LEVEL II (12)

AD A096828

Report NADC-75353-60

RETARDATION AND AUTOMATIC FLOTATION SYSTEM (R.A.F.T.)

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P.O. Box 180
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7 July 1980

Final Report for Period Feb. 1976 thru July 1980

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393C72

(9) Final rept. Feb 76-Jul 80.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

(19) REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER (18) NADC-75353-60	2. GOVT ACCESSION NO. AD-A096	3. RECIPIENT'S CATALOG NUMBER 828
4. TITLE (and Subtitle) (6) DEVELOPMENT OF RETARDATION AND AUTOMATIC FLOTATION SYSTEM (R.A.F.T.)		5. TYPE OF REPORT & PERIOD COVERED FINAL - FEB. 1976 THRU JULY 1980
		6. PERFORMING ORG. REPORT NUMBER (14) EDN-984
7. AUTHOR(s) D.R. HERMANN R.A. MILLER (16) F60532 (17) WF60532000		8. CONTRACT OR GRANT NUMBER(s) (15) N62269-76-C-0273
9. PERFORMING ORGANIZATION NAME AND ADDRESS AIR CRUISERS COMPANY P.O. BOX 180 BELMAR, N.J. 07719 393092		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS A340-0000/001B/1F60-532-000
11. CONTROLLING OFFICE NAME AND ADDRESS NAVAL AIR DEVELOPMENT CENTER (CODE 6013) WARMINSTER, PA.		12. REPORT DATE (11) 7 JUL[redacted]80
		13. NUMBER OF PAGES 111 (12) 112
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) (10) Donald R./Hermann Ralph A./Miller		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Distribution Unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Design, Fabrication and Initial Evaluation Test of prototype Retardation and Automatic Flotation Systems (RAFT) has been completed. The RAFT System will be used during transfer of sensitive Cargo during VERTREP operations. Design concept is based on an integrated parachute/flotation body. Overall system weight is 164 lbs. and packed volume is 4.3 ft.^{3} cu ft.

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S/N 0102-LF-014-6601

UNCLASSIFIED 393092

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SUMMARY

Introduction

This report documents the effort carried out in accordance with the scope defined by Naval Air Development Center, Contract Number N62269-76-C-0273 for the Development of a Retardation and Automatic Flotation System (RAFT) which will be used during Vertrep Missions.

The purpose of the RAFT System is to prevent damage and aid the recovery of high value cargo transported by helicopter externally over the open sea during VERTREP missions. The development and operational capability of the RAFT System would permit the authorization of external VERTREP of high value cargo. The results are increased operational efficiency, minimal cargo retrieval time and minimal fouling of at-sea flight decks--all resulting in cost savings. Currently the external carriage authority is being withheld pending the development of an acceptable loss preventing recovery system for high value cargo loads.

Summary of Results

System design and analysis has been completed and three prototypes have been built. Airframe interface and operational details have been established on the basis of installing the system on the CH-46 helicopter and using the operational MK-105 cargo pendant.

Static drop tests were conducted at Lakehurst Naval Air Station and NASA Research Center, Langley, Va. Also, Vibration testing to verify system structural integrity was conducted. The development has proceeded to where the design is ready for flight testing.

Overall system weight is 164 pounds and packed volume is 4.3 cubic ft. Salient performance characteristics are the ability to deploy and inflate within 1½ seconds, provide a 5000 lb. flotation capability, accommodate cargo weights of up to 3000 lbs., and automatic actuation by a single action. Detailed operating principles of the RAFT System are provided in the main text of this report.

Conclusions

Based on the results of the evaluation and testing to date, the RAFT System design approach has proven to be basically sound. The development has progressed to the stage where flight testing can be initiated after the following design modifications and evaluation tests are completed.

Recommended Design Modifications

All of the following modifications which are recommended can be implemented into the existing prototype systems.

(a) Incorporation of frangible pre-rigged "tension fuses" instead of nylon thread breakaway ties rigging of the bungee retarders.

(b) Installation of protective screen over aspirator inlet.

(c) Incorporation of improved internal intercompartment check valves in the inflatable.

(d) Increase the diameter of the ball and collet release cables to 3/32" and increase the length of the cable which retains the ball to $5\frac{1}{2}$".

(e) Increase the clearance between the ball of the latch mechanism and its guide cavity.

Recommended Support Tasks/Testing

(a) Repeat of drop tests at NASA Langley Research Center to verify function of design modifications.

(b) Modification of helicopter to interface with RAFT System for flight tests.

(c) Conduct of on-the-helicopter vibration tests by use of an "overweight" ballasted (150% of actual RAFT System weight) container as the initial flight test. This test will verify the structural adequacy of the overall RAFT System-to-helicopter installation.

Recommendations for Future Development

(a) Subsequent to the feasibility flight demonstrations reliability and maintainability plans and other appropriate system development documentation should be prepared.

(b) On the basis of the flight test results, the system design should be analyzed carefully, revised and upgraded as appropriate.

(c) Additional component and subsystem laboratory tests should be performed to demonstrate reliability and durability.

(d) Additional prototype systems should be fabricated for advanced and engineering development.

(e) Additional flight testing should be conducted to expand the flight envelope and to develop the design concept up to the point where hardware for actual production and operational use is procured.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

LIST OF APPENDICES

SYSTEM DESIGN TRADE OFFS AND ANALYSIS

The Retardation and Automatic Flotation (RAFT) System was developed as a solution to the problem of preventing damage and aiding in the recovery of high value cargo transported by helicopter externally over the open sea during Vertrep Missions. Transporting of cargo is performed at altitudes from 150 ft. to 1500 ft. at speeds of 0 to 100 knots with cargo weight ranging from 300 lbs. to 3000 lbs. (See Table 1, Tabulation of Operational Condition Extremes.)

The combination retardation/flotation concept was determined to be the best overall solution to the problem on the basis of comparing it against other possible solutions.

Other candidates for solving the problem were: rapidly deploying parachute with separate inflatable bags; parachute with separate solid rigid foam flotation.

In certain modes only flotation capability needs to be provided (at altitudes below 150 ft.). Under other circumstances, the retardation function must be provided in less than 3 seconds, or 150 ft. of free-fall, after any jettison action is initiated in order to limit water impact velocity to 100 ft. per minute. The most critical mode is having to provide an effective retardation function which occurs at flight speeds of 100 knots and flight altitude of 150 ft.

A conventional parachute would not deploy and become effective prior to water impact under these conditions.

The pros and cons of locating each of the candidates at either the helicopter, the payload. or onto the cargo sling/ bridle were also considered. All candidates were compared against the operating criteria for the missions.

Suspending the RAFT System from the underside of the helicopter results in the need for a single RAFT system per helicopter as opposed to a number of systems at each cargo installation or replenishment site. Also, with one RAFT per aircraft, the only requirement is that there be one RAFT cargo bridle per cargo. The RAFT system designed was analyzed on a failure mode and effects basis which considered failure modes that could occur during assembly, installation on the helicopter prior to Vertrep Missions, and removal from the helicopter for maintenance procedures. The hazard and hazard level by category utilized are defined by MIL-STD-882, System Safety Program for System and Associated Sub-systems and Equipment. Based on the results of the analysis, (See Appendix E), it was concluded that the RAFT system baseline design approach is sound, and the potential hazards which are identified can be eliminated or effectively controlled.

The RAFT system concept was definitized around a conventional hemispherical parachute that is aided in deployment by an inflatable substructure which provides flotation capability. Subsystems comprising the RAFT system are: the retardation/ flotation body, inflation subsystem, recovery load transfer subsystem and container.

PAYLCAD	3000 LBS.	3000 LBS.	3000 LBS.	3000 LBS.	300 LBS.
ALTITUDE	SEA LEVEL	1500 FT.	1500 FT.	150 FT.	150 FT.
SPEED	HOVER	HOVER	100 KNOTS	100 KNOTS	HOVER
IMPACT VELOCITY (MAXIMUM)	----	100 fpm	100 fpm	100 fpm	----
MODES REQUIRED	FLOTATION ONLY	RETARDATION/ FLOTATION	RETARDATION/ FLOTATION	RETARDATION/ FLOTATION	FLOTATION ONLY

TABULATION OF OPERATIONAL CONDITION EXTREMES

TABLE 1 TABULATION OF OPERATIONAL CONDITIONS EXTREMES

WEIGHT SUMMARY

The current prototype system weight is 164 lbs. A weight breakdown listing based on actual component weights is shown in Figure 2. This status will be updated after the design modifications recommended in Section 6.0 are implemented, and again after completion of flight testing at which time additional weight improvements will be proposed for implementation when the first operational systems are built.

RAFT System	Prepared by: D. Hermann	Date Prepared June 26, 1980
SUBSYSTEM	NOMENCLATURE	CURRENT WEIGHT, LBS.
Container Subsystem	Shell (cylinder)	15.0
	Front hat section	2.9
	Rear hat section	2.1
	Center hat section	2.1
	hat section	2.1
	Front and rear covers	4.1
	Rear channel release support	3.0
	Latch Support Container	0.7
	Latches (2)	0.3
	Slotted shaft	0.6
	Latch support, Helicopter	1.2
	Pivot Cable support (4 ea.)	2.0
	Cable	.7
SUB-TOTAL		36.8
RETARDATION/FLOTATION SUBSYSTEM	Sphere	6.0
	Leg 4 ea.	21.0
	Girt and Attachment	1.0
	Cement	4.0
	Parachute	32.0
SUB-TOTAL		64.0
INFLATION/RECOVERY SUBSYSTEM	Aspirator	8.0
	Recovery shackle	3.0
	Cylinder-charged	15.7
	Inflation valve	2.5
	Bridle and lower fitting	8.5
	Recovery Cable	7.0
	Shroud line/recovery fitting	2.0
	Ball and collet adapter	0.5
	RAFT Cargo pendant	14.0
	Recovery shackles (5 ea.)	2.0
SUB-TOTAL		63.2
TOTAL		164.00 LBS.

TABLE 2 WEIGHT STATUS REPORT

RAFT SYSTEM OPERATION

A description of the RAFT system's operation during the various operating modes follows.

CARGO TRANSFER

(Ref. to Figure 1 and Drawing D24805)

During normal replenishment operations the cargo is fitted with a four point RAFT bridle terminated with an automatic closing cargo hook connected in parallel with the MK-105 sling bridle. The helicopter maneuvers into position over the cargo, distal end of the RAFT pendant engaged in the helicopter suspension hook. The suspension hook is opened and the RAFT pendant is freed. The crewman reaches and engages the MK-105 pendant into the suspension (cargo) hook and then he similarly engages the distal end of the RAFT pendant into the RAFT bridle hook to complete the cargo-to-helicopter hookup operation. The helicopter takes off, transports cargo to its destination, hovers over the deck of the ship, a crewman grabs the reach tube of the MK-105 sling, the suspension hook is disengaged by the pilot. Secondly, the RAFT pendant is disengaged from the RAFT bridle cargo hook. The helicopter is now free to return for another load of cargo.

The only additional operations required to accommodate the RAFT system are those of the bridle attachment and detachment from the RAFT pendant at times of cargo transfer.

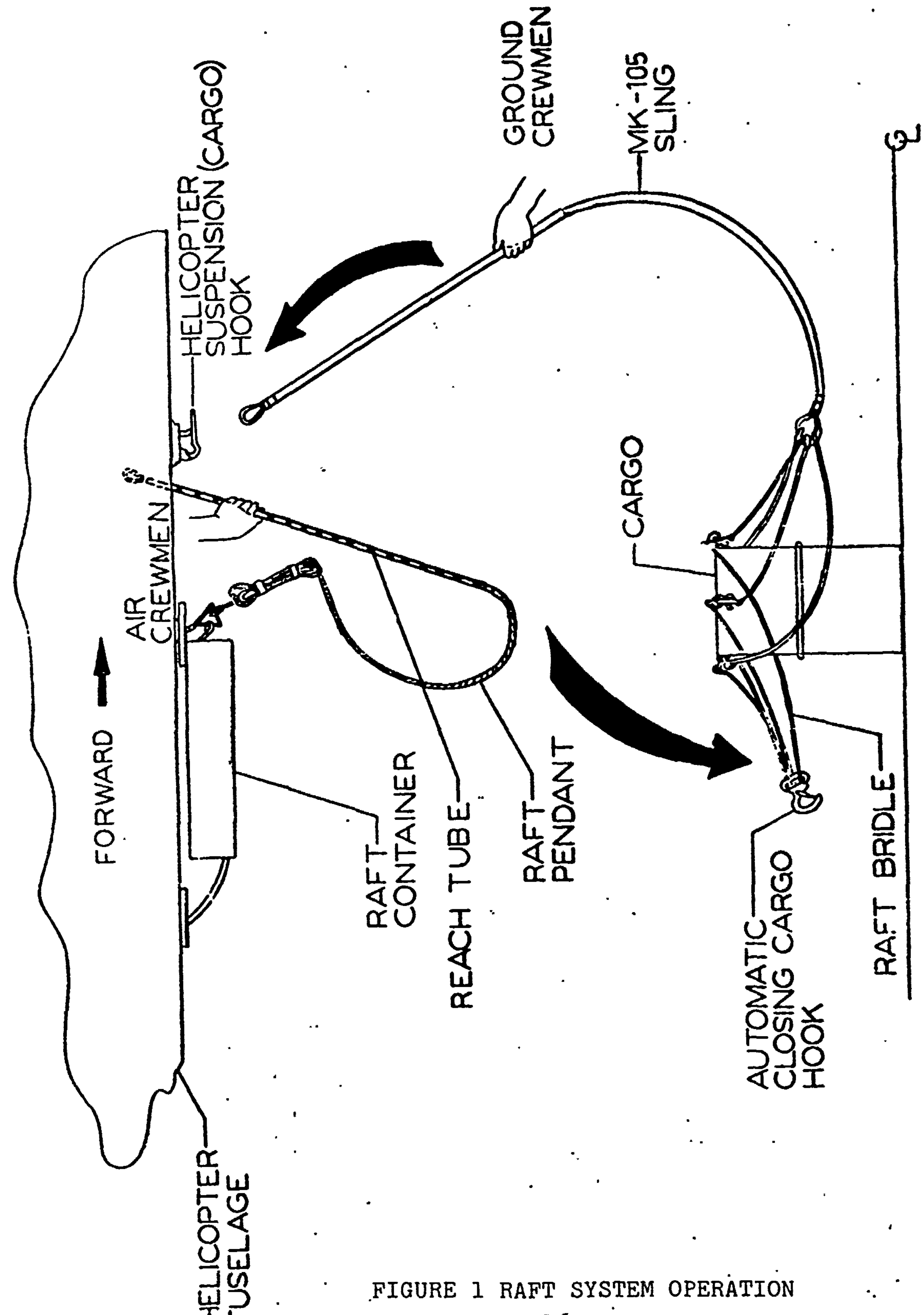


FIGURE 1 RAFT SYSTEM OPERATION

RAFT System Functional Sequence

In the event of an emergency which dictates that the cargo be jettisoned, the cargo hook release is actuated (See Figure 2). The cargo then falls free from the helicopter tensioning the RAFT pendant causing a "reefed" section of 6 ft. to break loose its restraining ties and extend. Subsequent to full extension of the pendant, the container cover, which is tied into the pendant, is separated from the container body by pendant tension, and the RAFT system is withdrawn from the container. Just as the last of the retardation/flotation body clears the container, the inflation lanyard is tensioned and inflation is initiated. As the system falls free from the container staggered, extendable "bungee" lanyards are tensioned to provide initial drag forces on the system to prevent the comparatively high density inflation system from toppling the parachute. When the parachute is approximately 22 ft. from the container, the first bungee is separated from the system by rupture of a frangible link. As the system continues to fall the second bungee is extended further until at a point 34 ft. from the container, its frangible link is broken also. See Figure 2-A for a plot of bungee retardation force vs. distance of system "free-fall". The system is fully deployed within 1½ seconds after start of inflation. Upon water impact, the cargo weight is transferred from the parachute shrouds to the recovery strap which runs from the lower apex

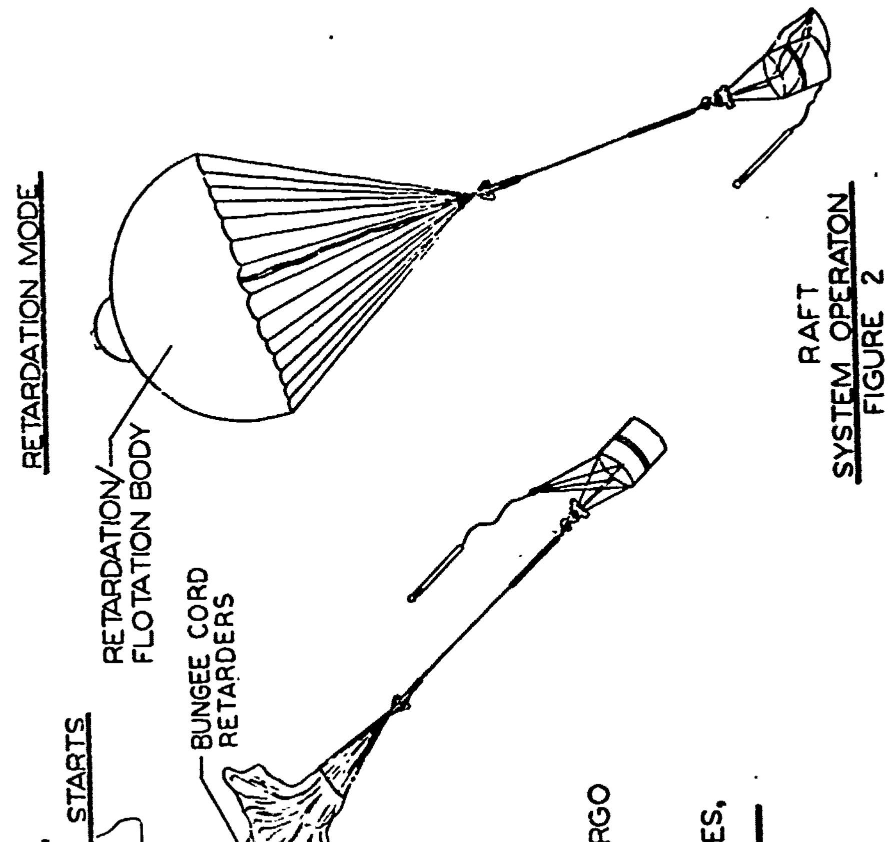


FIGURE 2 (SHEET 1 of 2) RAFT SYSTEM OPERATION
(FUNCTIONAL SEQUENCE)

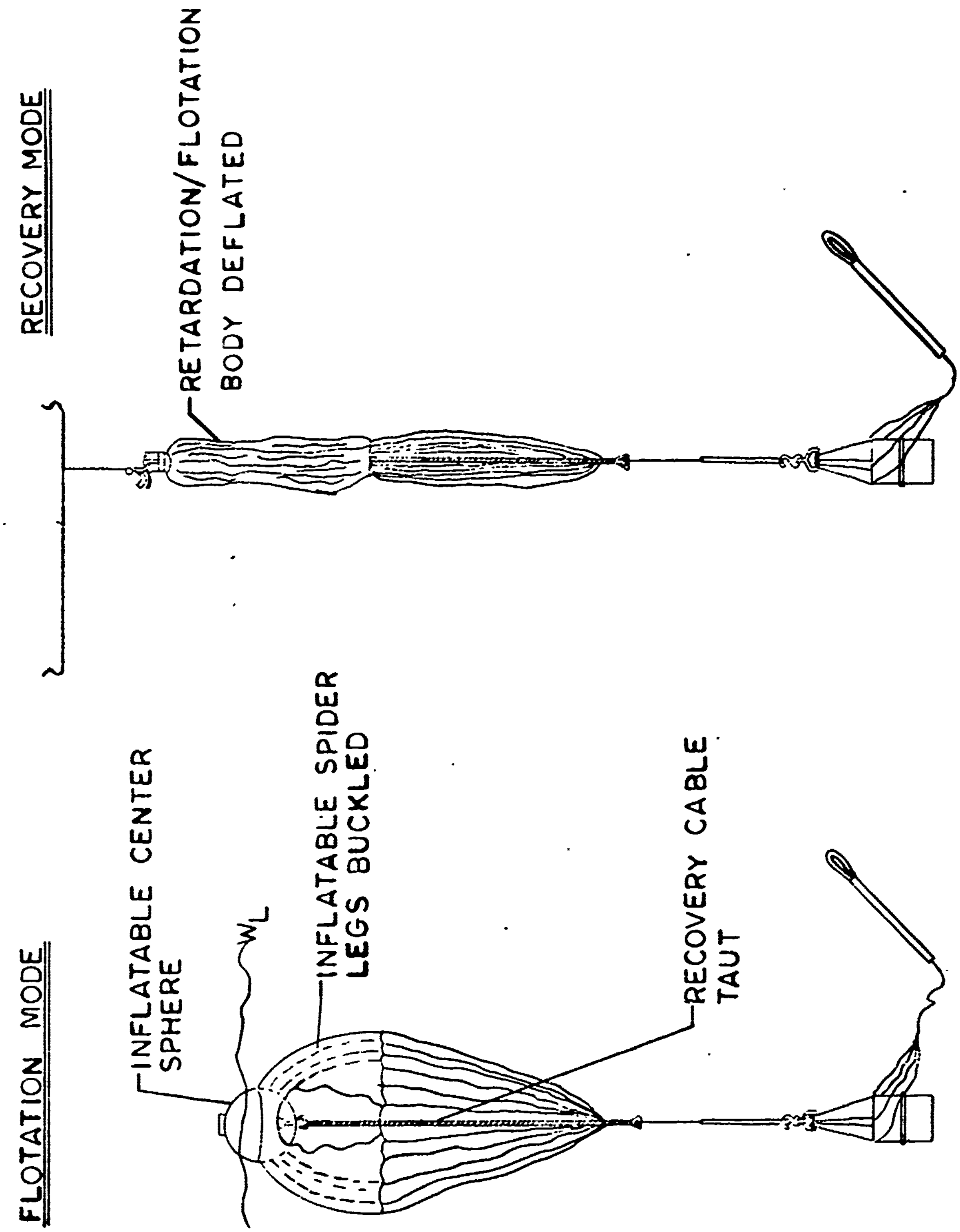
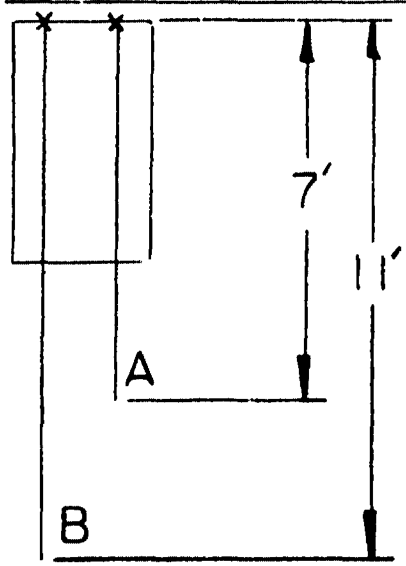


FIGURE 2 (SHEET 2 OF 2) RAFT SYSTEM OPERATION (FUNCTIONAL SEQUENCE)

RAFT-BUNGEE GUIDES



FUSE LINE "A" = 30 # (8'1" → 32'-2" @ 50 #)
FUSE LINE "B" = 70 # (11'-3" → 28 @ 50 #)

STRANDS OF 3/16" SHOCK CORD LINE A = 2
SIZE "E" THREAD " B = 3

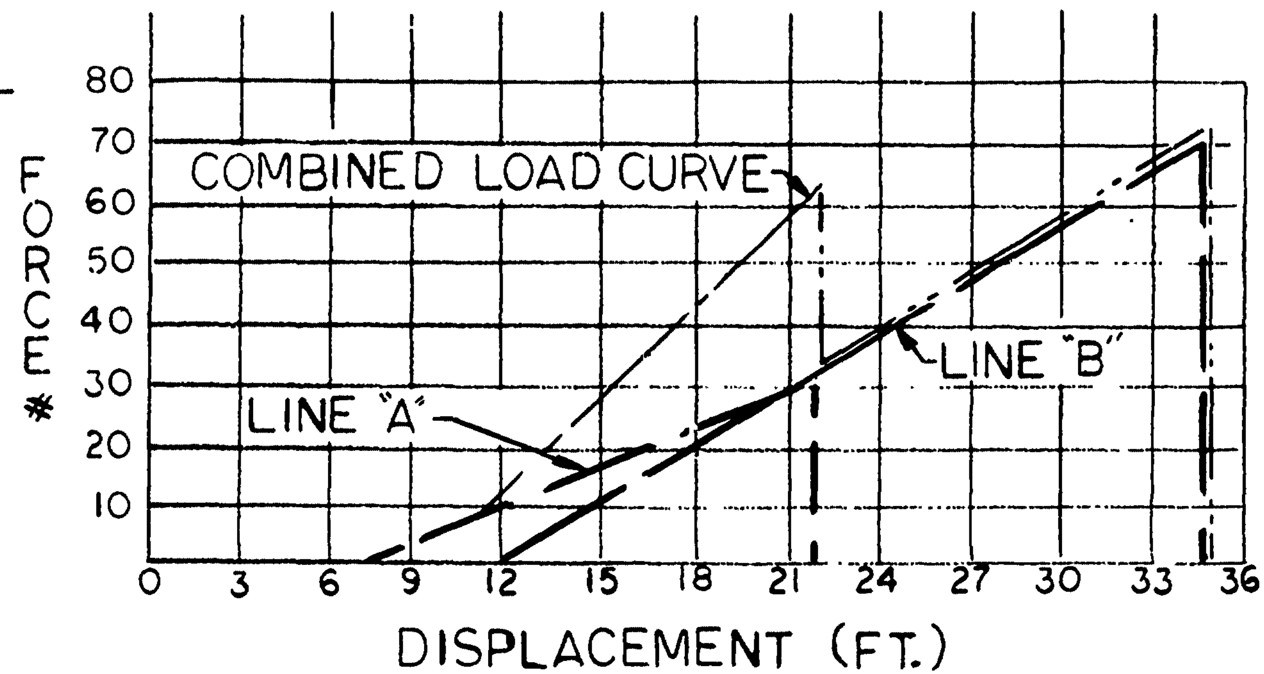


FIGURE 2A
BUNGEE FORCE
VS
DISTANCE OF FREE FALL

of the flotation body center sphere to the upper end of the RAFT pendant.

Flotation attitude of the system is such that approximately the upper half of the sphere floats above the water when the design maximum payload of 3000 lbs. is supported. The minimum displacement volume of the flotation body is 80 ft^3 (provides a buoyancy of 5000 lbs. in fresh water). The cargo is suspended approximately 35 ft. below the surface of the water. During recovery operations, the cargo transfer load path is via the recovery strap to a fitting at the bottom of the inflatable sphere. Load is then transmitted through the inflatable sphere by a three point bridle to the recovery pickup attachment (See Drawing D24805, sheet 3).

SUBSYSTEM DESIGNS

Inflation Subsystem

The inflation subsystem consists of an aspirator (ejector), a lanyard activated "dump" (inflation) valve, and a high pressure gas storage reservoir.

The system is actuated by withdrawal of a lanyard from the inflation valve which initiates air flow directly into the primary discharge passages of the aspirator from a high pressure stored gas reservoir containing a compressed gas charge (CO_2/N_2 mixture) at 3000 psig and 70°F. The aspirator, inflation valve and cylinder are directly coupled together both pneumatically and structurally which eliminates the need for any interconnecting hoses and simplifies the mounting of the subsystem within the inflatable body.

The aspirator is configured such that a formed steel recovery pickup point or spider is attached directly to its secondary, or ambient air, inlet section. This device (refer to Drawing ERD17806, Aspirator Assembly) inducts the secondary, or ambient air portion of the inflation gas mixture through a circular inlet having a cross sectional flow area of approximately 12 in^2. The secondary inlet is essentially flush with the fabric inflatable wall. It is "valved" by means of a spring loaded poppet that is opened at initiation of inflation by the inductive effect created downstream of the poppet by the inrushing high pressure, primary, constituent of the inflation gas. The primary gas manifolding is directed so that it flows radially outward into a radial plenum where the secondary air mixes with high velocity primary gas. After mixing the gas continues to move radially outward through a diffuser section where the mixture is compressed, finally exiting into the inflatable. After distension of the inflatable has been accomplished and a significant positive internal pressure has been achieved, a spring forces the poppet closed. The poppet is contoured to assist in changing the direction of the secondary flow as it is inducted by the expansion of the primary gas stream in the venturi mixing area. Compared to "flapper" type valves, the poppet configuration exhibits a more stable positive, closure action when backflow of primary gases occur at the time when distension of the inflatable has been accomplished and a significant positive internal pressure has been achieved. At this point, the inlet is sealed and the residual primary gas continues to flow, "topping off" the inflatable.

The discharge valve (see Drawing ERD17783, Inflation Valve Assembly, and Figure 3) is a ball valve, actuated by a lanyard. A pressure gage, Part Number C18225-501, to provide an indication of system readiness is mounted on the inlet side of the aspirator to permit reading the gage after the RAFT system is packed into the container.

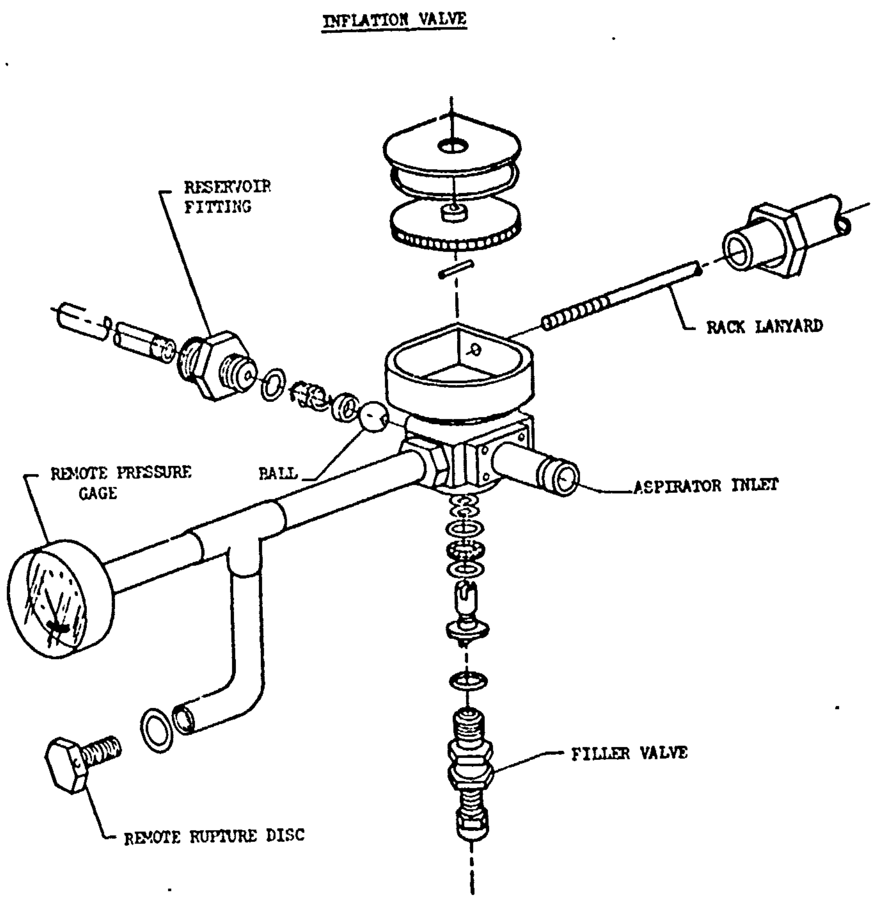


FIGURE 3 INFLATION VALVE BREAKDOWN

The remotely mounted burst disc which provides reservoir overpressure protection, (See Figure 3) is also located outside the inflatable body so in the event of the disc rupturing the contents of the high pressure reservoir are exhausted outside of the inflatable flotation body. Thus, overpressurizing of the container or inadvertent expulsion of the RAFT System are prevented.

The discharge valve lanyard opens the valve (rotates the flow ball) by means of a rack which is in engagement with a pinion. This pinion is keyed to a shaft which engages the "flow-ball" of the valve (thus pinion and ball rotate in unison). The end of the lanyard is mechanically fastened to the "aft" end of the container. The stored gas reservoir used for the prototypes (Part Number 16D17194-10) is a drawn steel cylinder which has a capacity of 425 cubic inches (See drawing 16D17194 for other reservoir details.) Operational systems will employ 500 in^3 reservoirs, P/N 16D17194- 13, (Prototypes were "overcharged" to 3500 psig in order to achieve 3.0 psig pressure in inflatable.)

RETARDATION/FLOTATION SUBSYSTEM

The Retardation/Flotation Subsystem consists of a ring slot parachute and an inflatable flotation assembly. (See Drawings D24805, sheet 3 and ERD24745). The parachute is a 22 ft. diameter, "ring slot", cargo extraction model, with the ability to withstand the opening shock imposed by a 3000 lb. cargo at 130 knots and limit the rate of descent to 100 ft. per second. The parachute is modified by reinforcement of the vent and elimination of the shroud lines over the top. Elimination of shroud line "cross-over" enables the ambient air entrainment inlet of the aspirator, which is located in the upper apex of the flotation sphere to protrude unencumbered.

The inflatable flotation body which expedites the deployment of the parachute consists of a sphere 40 inches in diameter with four legs attached at its mid-center line and canted down 19°. The sphere and legs are constructed of yellow two ply urethane coated nylon. This urethane coated fabric utilizes the following salient features:

(1) Urethane compounds are not subject to age-dating limitations. With proper care and maintenance, useful life of the equipment is indefinite.

(2) Toughness and abrasion resistance are excellent. Chafing and abrasion protection considerations are thus less critical. Moreover, the rigors of packing are better sustained by urethane coated product. A "tight pack" requirement

is implicit in most inflatable survival equipment applications.

(3) Urethane adhesive systems give seam strengths in peel that exceed coating-to-base fabric adnesion values , primarily due to the chemical cross linking that takes place during cement cure. In addition, seams have unsurpassed high temperature load carrying capabilities. Adhesive joints demonstrate the capability to carry dead loading equivalent to "burst level" hoop loads at temperatures of up to +220°F.

(4) Repairability is enhanced. Here, again, the urethane elastomer coating/adhesive system is one which provides maximum bond strength and optimal sealing characteristics with only minimum preparation of the fabric being required prior to repair. Moreover, the rapid cure rate of urethanes compared to either neoprenes or natural rubber systems results in minimum downtime for repairs (i.e., 90% of final bond strength can be achieved in less than 24 hours at normal ambient temperature. Leak testing can be accomplished within four hours after repair).

The sphere is fabricated from eight fabric panels, or gores. Construction details of the inflatable are as follows: All seams are butted construction with 2" inside and outside tapes.

In the sphere there are two penetrations--one located at the top to provide for installation and mounting of the inflation system, and the other located at the bottom for the lower recovery strap-internal bridle transition fitting. Both openings are reinforced with a 1/8" thick neoprene collar and a 3/16" thick aluminum ring. The top reinforcement ring has been drilled and tapped to allow bolting of the mounting flange of the aspirator to the sphere. The neoprene material provides for a good compression seal between the aspirator and the sphere, as well as providing a degree of flexibility to the seal area to accommodate buffeting effects in the air, at impact, or afloat.

The four legs of the inflatable are symmetrically positioned around the equator of the sphere. Each is 24 inches in diameter and approximately 61 inches long. A fabric check valve is installed in each leg which allows inflation gas to enter the leg from the inflation system in the sphere but will not allow the gas flow to return. However, a loss of gas in a leg would cause the sphere to be bled down through the open check valve. For this reason, the design buoyancy was set at 167% of the maximum payload weight to allow for this type of pressure loss.

A total loss of gas in the sphere due to a leak in the leg is highly unlikely since water pressure would trap gas in the upper portion of the sphere above the check valve opening, thus adding an additional buoyancy safety margin. Mechanical check valves were examined and considered which would not only provide a check valve function, but would also stop the flow from the sphere to the leg when the pressure in the sphere dropped below .25 psi.

The size, bulk and rigidity of these valves makes their use impractical.

The flotation body is attached to the parachute by a nylon cord belt inserted through interlocking loops attached to the sphere and the parachute. The ends of the belt are connected together by a clevis. The shroud lines provide a $1\frac{1}{2}$" to 2" clearance between the parachute and the sphere which is necessary to prevent the sphere from plugging the opening in the upper ring slot and therefore not allowing the proper venting during opening and descent. In addition, this type of interconnection prevents loads which are transmitted through the shroud lines from being imposed on the inflatable.

The outer end of every leg is attached to the inside of the parachute canopy by the use of velcro fasteners which are located on each leg.

CONTAINER

The RAFT container (Drawing D24805, Sheet 2) is a welded aluminum cylindrical structure with four equally spaced externally spot welded, hat section, circumferential stiffeners. The rear end cap is permanently riveted to the container. The front cover is retained as a "snap-fit" to the container which mate with "depressions" at corresponding locations on the cover flange.

The container's inside diameter is $14\frac{1}{2}$"; outside diameter is 15-3/4"; overall length 45 inches, and provides an internal "pack volume" of 4.3 cu. ft.

The forward end of the container is mounted to the helicopter by means of a cargo activated, staged, release device and latch mechanism. The aft end of the container is mounted to the helicopter by two swaged cable assemblies. Both front and rear attachments tie into mounting brackets which in turn are attached to the helicopter by means of "fail-safe" shear pin installations which permit the entire RAFT system to break away from the helicopter if failure of the release mechanism, failure of the RAFT system to deploy or other "hang-ups" should occur. Design breakaway force for the shear pins is 750 lbs. A manual backup jettison capability is also provided. Each shear pin has a 1/16" cable/pull handle attached to it. The pull handles are accessible to the crewman within the helicopter. If the RAFT system must be jettisoned both shear pins can be withdrawn from their sockets to permit the RAFT system to fall away from the helicopter.

The forward release mechanism which isolates the latch from flight loads consists of a ball and collet assembly. The ball assembly of the ball and collet is attached to the container's forward mounting bracket support. The collet end is attached to the ball and collet adapter which in turn ties into the recovery load transfer subsystem using a removeable clevis. This allows the ball and collet assembly to be serviced independently, off the helicopter. (See Figure 3-A for details.)

The latching mechanism which also provides lateral stability to the forward mounting consists of a rotatable shaft with a milled slot cutout at each end. The slotted shaft is supported by two shaft support blocks assembled to a tie plate. Both support blocks house detent assemblies which prevent shaft rotation due to inflight loads and vibration (and consequent inadvertent unlatching of the system). The shaft support blocks are aligned and pinned as an assembly. Two "L" shaped lugs fit into the slots on the shaft. These lugs are free to rotate 360° in their supports. The lug supports are aligned and pinned prior to being mounted to the container forward support.

In order to secure the latch, the shaft which is attached to the helicopter is rotated so that the open end of the slots face downward. The "L" shaped lugs which are attached to the container are slipped into the slots. At the same time the ball end of a ball and cable which actuates (unlatches) the mechanism assembly is located between two pins which project from the shaft.

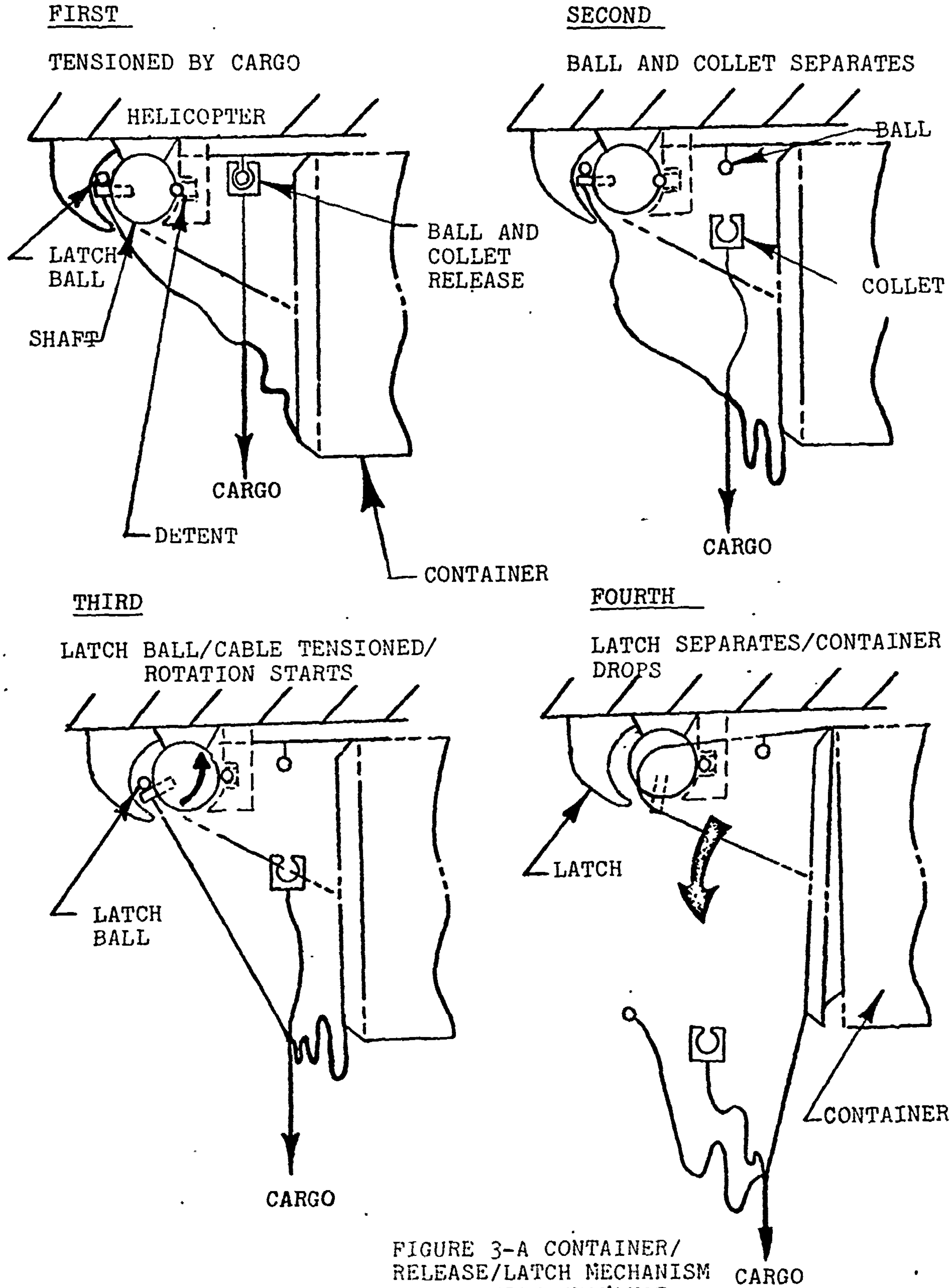


FIGURE 3-A CONTAINER/
RELEASE/LATCH MECHANISM
FUNCTION SEQUENCE

Then the shaft is rotated 90° into the latched position (detents are engaged) by turning the "L" shaped lugs (slotted ends) with a screwdriver. At the same time the ball and cable is drawn up into a retainer/guide recess, or cavity, which positively retains the ball.

The lower end of the actuating ball and cable assembly is attached to the ball and collet clevis.

The "flexible" aft mounting bracket which permits the container to swing and pivot after latch release consists of two 3/8" diameter wire rope assemblies with swaged end fittings, bracket spacer, bracket mounting plate, and stiffener. (See Drawing D24805).

The swaged fittings are attached to the aft end of the container by clevis joints and the upper cable ends are bolted to the aft bracket mounting plate which is then retained to the helicopter by a "fail-safe" shear pin/socket installation. The aft bracket spacer which is contoured to provide a snug fit with the radius of the container is bolted to the mounting plate and provides stability in the transverse direction.

The final "fail-safe" shear pin design concept of "single pins" at the forward and aft attachments was selected to assure a positive uncomplicated "breakaway" capability.

Dual shear pins as originally envisioned would have complicated the design and introduced the potential for jamming/cocking of the mating parts within the breakaway mechanism. Structural adequacy of the RAFT container and its interface with the helicopter were verified by Boeing-Vertol under sub-contract. See Appendix A for the results of this analysis. As noted in this Appendix, the structural adequacy of the RAFT system-to-helicopter attachments is debatable. In order to verify the adequacy of the entire RAFT-to-helicopter structure and mechanism, it is recommended that as the initial flight test a RAFT container be "ballasted" to 150% of the system weight (150 x 164 = 246 lbs.) and evaluated/verified by being subjected to the actual helicopter dynamic flight environments.

RECOVERY LOAD TRANSFER SUBSYSTEM

The RAFT"load carrying chain" is designed to work in conjunction with the MK-105 cargo pendant and bridle assembly during airlift of cargo by helicopter. The cargo requires attachment of the RAFT cargo bridle to each cargo item which will remain with the cargo after cargo is released from the helicopter during unloading. (See Figure 3-B for a schematic of this subsystem)

The RAFT cargo bridle (See Drawing ERD24741) is composed of four, equal length, 90 inch long legs with adjustable safety hooks connected to one end of each leg. The other ends of the legs terminate at a suspension clevis.

An adjustable safety hook at the clevis end of the bridle is the point at which the RAFT pendant is connected when airlifting cargo. The RAFT pendant (See Drawing ERD24752) which connects to the cargo bridle, is similar to the MK-105 cargo sling. It is rigid and has a formed loop located at each end. One end is permanently attached to the RAFT recovery strap by a hoist link and the other end is tied into the RAFT cargo bridle.

The main recovery strap (See Drawing ERD24739) which interconnects the RAFT pendant to the lower apex of the inflatable sphere at a transition fitting is constructed from 1.75 inch wide webbing which has a minimum breaking strength of 16,500 lbs. Sewn to the main strap are transition straps which have a minimum breaking strength of 5,500 lbs. each and provide the attaching points for the parachute. The upper end of the recovery strap

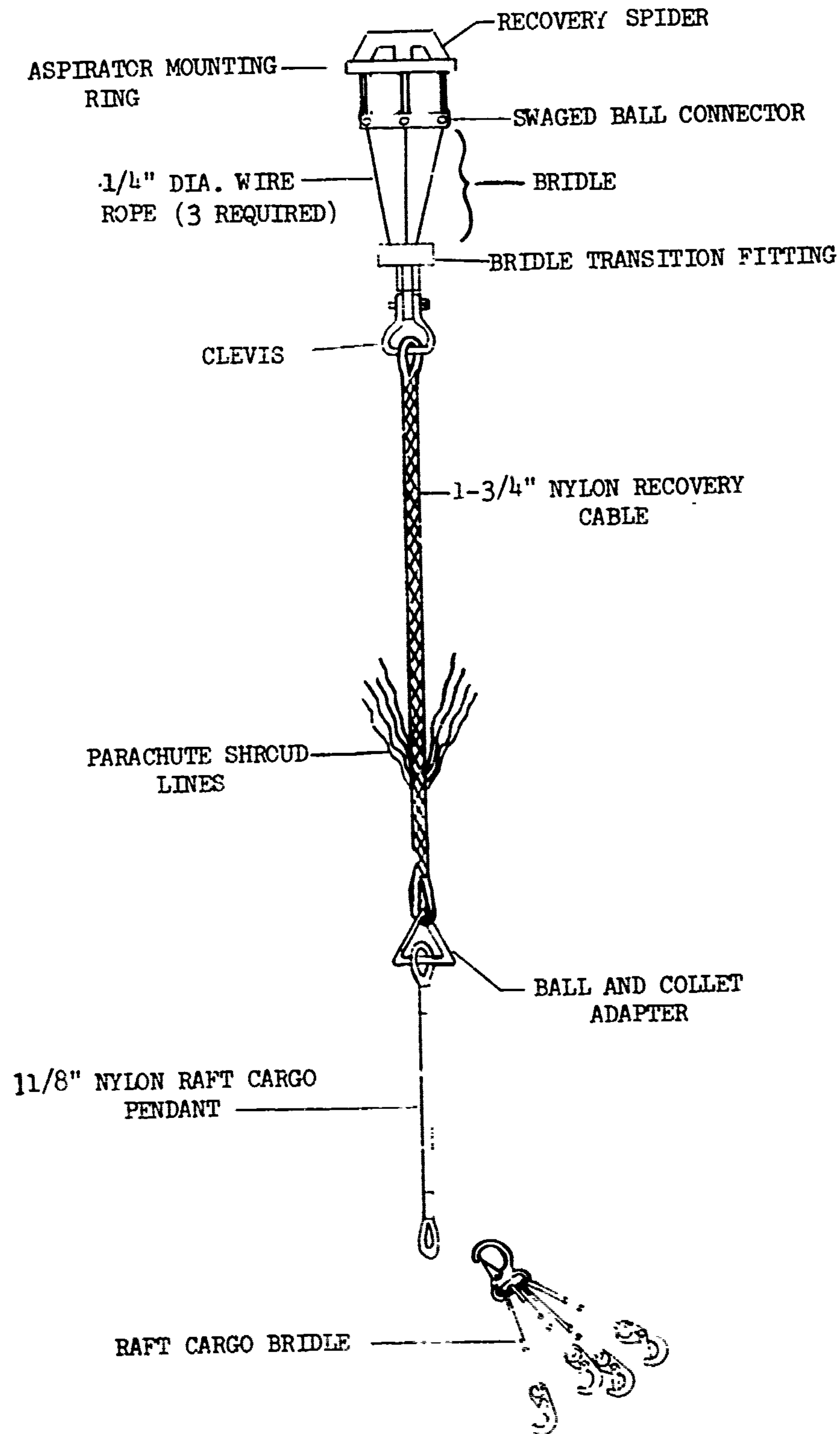


FIGURE 3-B "LOAD CARRYING CHAIN" SCHEMATIC

connects to a bridle transition fitting which is installed at the lower apex of the inflatable. This transition is also the "base" fitting of a bridle inside the inflatable. A 3 point bridle (See Drawing C16567) was chosen to insure equal tension without the need for individual cable length adjustments. Wire rope 1/4" in diameter with a minimum breaking strength of 6400 lbs. is used for each leg. The three cables are terminated at each end with a swaged ball. The upper end of each cable is retained within a socket that threads onto tie bolts which in turn are seated in the recovery attachment (spider).

Evaluation and Testing

Initial Deployment/Inflation Verification

Initial testing of the RAFT container release mechanism was performed at Air Cruisers Company, Belmar facility. A ballasted container assembly was attached to a mockup structure which simulated the underside of the aircraft fuselage. Sand bags (120#) were used to simulate the payload.

The mockup and container assembly were hoisted 15 ft. into the air, mockup secured, and then container release mechanism was actuated by sand bag free-fall. After successfully completing two trial releases, a problem with the release mechanism developed on the third trial. It was determined that the use of a pin as the "lever" to rotate the shaft of the release mechanism was directionally sensitive. Under some pull angles, it separated prematurely and at other payload angles of pull, it hung up. The release mechanism was modified to incorporate a ball and cable/pin interconnection to rotate the shaft. The ball and pin is less sensitive to variations in payload angles of pull. A fourth deployment test was then conducted at Belmar after completing the modification to the release mechanism. On the fourth test, the mockup and a complete RAFT system (instead of ballasted container) were hoisted to a height of 25 ft. above the floor. The release mechanism was operated and the RAFT deployed and inflated successfully to 1.5 psig.

Lakehurst Naval Air Station Drop Tests

The testing at Lakehurst took place inside Hangar 1 which has a ceiling height of approximately 185 ft. at the center catwalk which permitted a payload free-fall height of 167 feet. (See Appendix C for test plan.)

The RAFT System was suspended from a traveler located in the hangar overhead and was mounted on an aluminum channel structure to simulate its installation on the aircraft.

Problems were encountered on the first static drop test. The system did not deploy because the container release mechanism did not separate. Examination disclosed that the ball termination on the mechanism release cable was able to pass to the outside of the release pins and thus separate from the mechanism without rotating the shaft. A design modification was implemented wherein the ball is positively contained between the release pins to prevent it from separating until full rotation of the shaft (i.e. separation from the mounting bracket) occurs.

The second test resulted in a complete deployment. The inflatable did not fully distend because the reservoir pressure was approximately 2500 psi instead of 3000 psi due to a leak in the valve.

On the third test a problem was encountered when the inflation valve did not open. Investigation of the valve mechanism disclosed that the valve pinion had disengaged (i.e. jumped) from the shaft. This was a result of the retaining nut being inadvertently left off. The damaged pinion and shaft were replaced and the system was repacked for testing.

The fourth "drop test" resulted in a complete deployment. The inflatable distended to its full shape but the inflatable pressure was marginal (0.50 psig). An observation which was made during the deployment by witnesses of the test was that "the top of the parachute seemed to be falling faster than the skirt of the parachute". This observation was verified by the films and the parachute manufacturer was contacted.

The fifth "drop test" was conducted using a payload weight of 254 lbs. (Previous test payload weight was 126 lbs.) The additional weight was used in an attempt to rectify the "toppling" effect of the parachute. Also the strap between the inflatable and the payload was shortened to carry some of the payload weight during the inflation sequence. This was to allow the inflatable to pressurize without the weight of the payload holding the legs down (i.e. reduce inflatable back pressure during inflation sequence). The payload weight had previously been transmitted to the inflatable legs by the shroud lines.

The system deployed satisfactorily and the inflatable fully distended to shape. As in the previous test, the inflatable pressure was [illegible].50 psig. The inflation subsystem was tested at Belmar to determine the cause of the low inflatable pressure. The system was recharged and functioned while suspended from the ceiling (i.e. "hang" deployment). The pressure of the inflatable was traced by a strip chart recorder. Results of the tests showed an extended amount of time for the cylinder to discharge. After an examination of the valve, it was determined to have partially reclosed during the inflation sequence. To verify this result a second inflation run was performed and similar results obtained. The locking pin was not fully engaging which allowed the valve pinion and shaft to rotate and partially reclose the valve. A modification to extend the valve detent which locks the pinion in the open position was implemented and tested satisfactorily. The RAFT system was repacked for the sixth test.

The payload weight remained at 254 lbs. for the sixth test sequence. Again, a complete deployment was witnessed and the inflatable terminal pressure was 0.75 psig. To diminish the "toppling" effect of the parachute, a bungee was placed between the top plate of the aspirator and container. The bungee cord provided a retarding force to the top of the parachute until the fuse link broke at 30 lbs. Films of the test showed that the "toppling" effect was diminished while the bungee was connected but became noticeable after the separation of the bungee. Representatives of the parachute manufacturer, Pioneer Parachute, reviewed the films of this test to aid in ascertaining the cause of the "toppling" characteristic of the parachute. The consensus of opinion was that the parachute would recover in what was termed a "catapult" effect once the skirt of the parachute filled with air.

Inflation trials were performed at Belmar in an attempt to increase the final pressure and at the same time to decrease inflatable roundout time (i.e. time to design shape). A quicker roundout time would increase the drag on the top of the parachute causirg a natural recovery force. In order to speed up the inflation time, an inflation gas mixture of carbon dioxide and nitrogen was used instead of pure nitrogen, and the time to 0.75 psig decreased from 4 seconds to 1.5 seconds and final pressure increased to 3.9 psig.

Also, a second bungeė cord was incorporated to lengthen the time that the "retardation force" acts on the top of the parachute. The additional bungee has three shrouds of 3/16" diameter cord and picks up the load prior to the primary bungee cord separation. The secondary bungee produces a "retardation force" of 70 lbs. before it separates. (See Figure 4-A,Retardation Force Profile Plot)

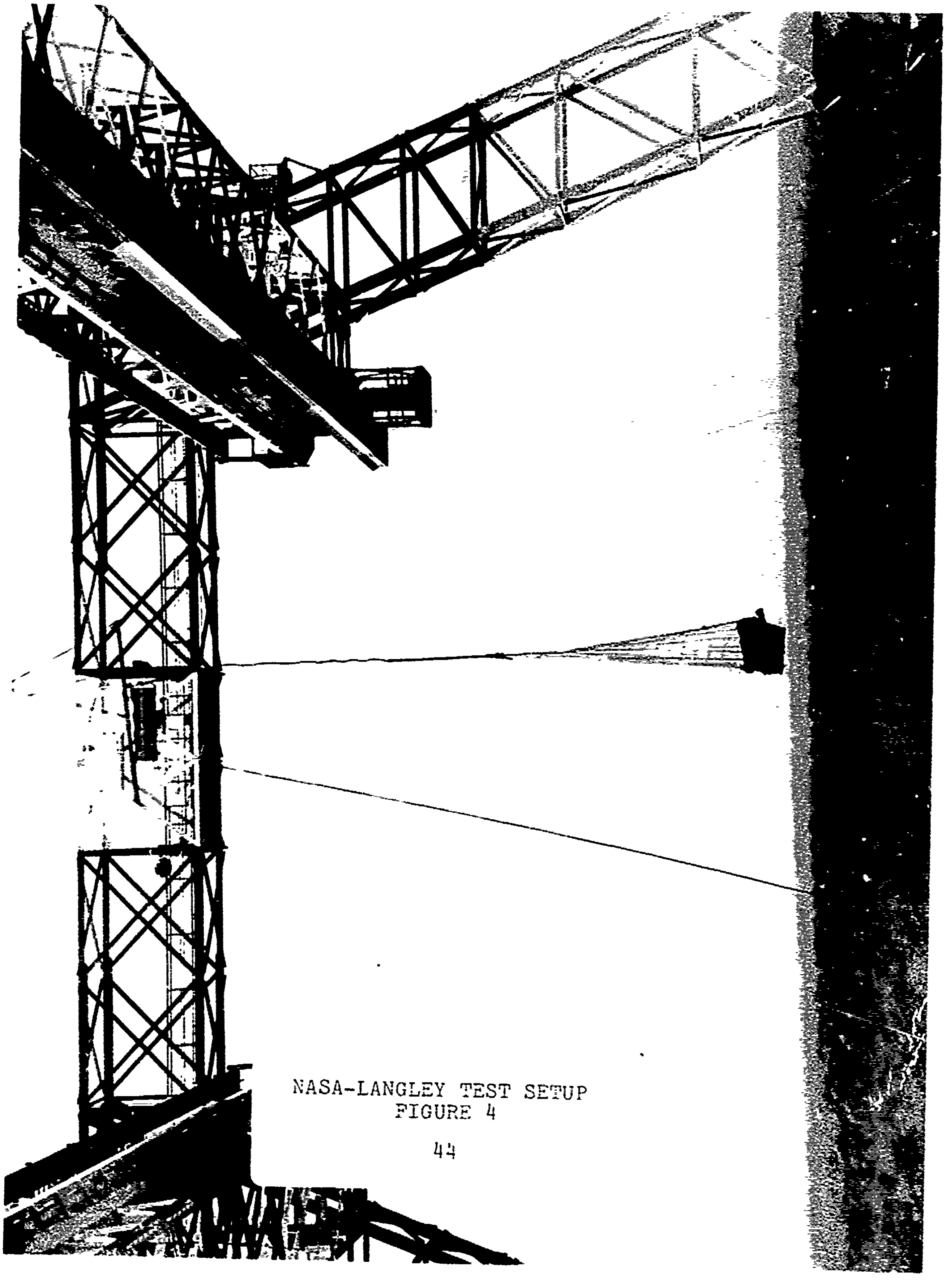
After successfully completing the seventh and eighth drop tests at Lakehurst, the three prototype systems were prepared for a series of deployment tests at NASA Langley Research Center.

Langley Research Center Drop Tests

The Airplane Crash Facility at NASA Langley Research Center, Langley, Virginia was the site used for the following series of static drop tests. Test setup and procedures were similar to the Lakehurst tests except drop height was 200 ft. and the simulated payload weighed 1000 lbs.[(1)] (See Figure 4 for a photo of the setup and Appendix D for additional test details.)

Raft prototype Serial Number 001 was deployed first. The wind velocity was 10 to 15 miles per hour from an East-to-North East direction; ambient temperature was 73°F. The deployment/inflation sequence was as intended. (i.e. cargo hook release, transfer of load to RAFT pendant, ball and collet release, container release mechanism rotation, container pivoting about aft attachment cables, parachute and inflatable extracted from

(1) A closer simulation of actual flight test condition.



NASA-LANGLEY TEST SETUP
FIGURE 4

container, inflation actuation, bungee separation, full blossoming of parachute and a final inflatable pressure of 3.0 psig) Full blossoming of parachute was observed at approximately 1/3 of the free-fall distance (i.e. approximately 70 ft.)

In the second test, S/N 003 deployed satisfactorily in a 17 mile per hour wind from an East-North East direction and a temperature of 74°F. Ground personnel observed that one leg of the inflatable seemed to lag behind the others during pressurization. As the system hung from the snubber lines, one leg of the inflatable seemed to be losing rigidity.

Subsequent to lowering the inflatable from the tower, it was observed that the leg had lost pressure through a topping-off valve inadvertently left open. The remaining legs had final pressures of 0.75 psig.

System S/N 001 was repacked. (The "three strand" bungee was replaced due to slippage of fasteners.) System Serial Number 001 was deployed in a 10 to 18 mile per hour wind from the East and at a 73°F temperature. The system deployed satisfactorily; full deployment of the inflatable and then quick depressurization was observed. After lowering the inflatable from the tower it was observed that the bungee cord had ruptured prior to the "breakaway" tie and had trapped open the aspirator poppet. Also, all legs of the inflatable were depressurized, indicating that the intercompartment check valves did not perform their intended function.

RAFT system Serial Number 002 was installed on the mockup and upon checking cylinder gage pressure prior to test, a cylinder pressure of 2800 psig, about 600 psig below nominal charge pressure,was observed. The decision was made to proceed in spite of this low pressure indication. The system was functioned in a 10 to 18 mile per hour wind from the East with a temperature of 78°F. Results were identical to the third test (i.e., full deployment followed by complete depressurization of the inflatable caused by aspirator ingestion of a broken bungee cord and all compartment check valves failed to seal).As result of investigation and cause analysis efforts subsequent to the LRC tests, the cause for the deployment anomalies observed were as follows.

(a) The cause of the rupture of the "Bungee" cords was found to be improper installation of the nylon thread breakaway ties due to an error in the procedural write-up for the rigging of these breakaway links. (The thread size was called out as size "F" thread instead of size "E". Thus the breakaway strength for the ties was approximately 50% higher than intended and the "bungee" broke first). Corrective action is to use pre-rigged frangible tension fuses which are "keyed" to prevent their being incorrectly installed (i.e. "reversed").

(b) The failure of aspirator inlet to close was a consequence of the bungee breakaway tie error described above. If the bungee breakaways had been correctly rigged, the cords would have retracted into the raft system container instead of being "slingshotted" into the aspirator inlet. None-the-less, as a positive corrective action, a protective screen will be installed over the aspirator inlet. There is adequate space within the head end of the container to permit the use of such a screen without compromising the air entrainment efficiency of the aspirator.

(c) The failure of internal check valves to seal was made evident because of the failure of the aspirator poppet to close at the end of the inflation cycle. It has been determined that the "duck bill" check valve installations which admit gas into each of the four (4) "legs" of the inflatable will not seal (check) unless the pressure in the inflatable leg is above 0.50 psi. The fabric sealing lips of the check valves must be pretensioned to effect a positive closure of the valve. (This pretension can only be obtained by tube hoop tension at inflatable pressures above0.50 psi).

During the "drop test", since the aspirator inlet did not reclose, a pressure in the center spherical section of the inflatable probably never exceeded 0.50 psi, thus the legs of the inflatable were at some pressure below that value; and after the sphere depressurized, the check valves were not effective in maintaining pressure within the inflatable.

An improved check valve configuration has been designed that utilizes a second pair of sealing lips in series (overlapping) with the existing primary sealing lips of the valve. These secondary lips are fabricated from an unsupported elastomeric sheet. (The primary sealing lips are fabricated from a supported material, urethane coated/woven nylon substrate). Thus the secondary lips have considerably more "stretch" than the primary lips. Since the secondary lips can be prestretched when they are bonded over the primary lips, a positive seal is effected that is independent of the tension on the primary lips (i.e. not dependent on a positive inflatable pressure). A prototype valve installation has been fabricated and proven to solve the problem.

Vibration Tests

Vibration testing was performed under subcontract by Dayton T. Brown, Bohemia, Long Island. (See Appendix B for the Dayton T. Brown Test Report). Initial vibration testing was performed per MIL-STD-810C, Procedure IIC. The purpose of this test was to determine if the RAFT system equipment is constructed to withstand expected dynamic vibrational stresses and to insure that performance degradation or malfunctions will not be produced by the service vibration environment. Summary discussions of test results follow. During the second 15 minute sweep (5 to 500 to 5 hertz), the container was automatically released due to the breakaway tie wire of the latch actuation ball cable assembly becoming "slack". This permitted the shaft to rotate because the mass imbalance of the ball and retainer pins imposed a "release torque" on the shaft.

The third sweep resulted in the tie wire breaking, enabling the shaft to rotate again releasing the container. Testing was discontinued.

During all of the above testing, excessive amplification was observed. The primary cause for the amplification was that there was excessive free-play in the forward attachment mechanism in the pitch, roll and yaw directions. Also, the chord length and footprint area of the interface between the container and the aft bracket were insufficient and permitted approximately 1/4" of lateral movement which added to the vibration induced amplification.

The forward mounting bracket assembly was modified by the addition of "30 lb." detent assemblies in the mounting block as described previously. This eliminated the tendency of the shaft to rotate due to the mass imbalance of the ball cable and retainer pins. Also the shaft was redesigned with tighter tolerances to eliminate the excessive free-play.

The chord length on the aft mounting bracket was increased from 6" to 12". Also a tighter fit was obtained by using a higher durometer neoprene for the pads between the bracket and the container. An additional stiffener web which eliminates the tendency for the aft mounting bracket to flex due to lateral "G" loading was incorporated also.
After completion of these design improvements, vibration testing was resumed.

The first series of lateral testing starting again with 5 hertz going to 500 hertz and then returning to 5 hertz as required by MIL-STD-810C were initiated.

During the first sweep at 26 hertz, there was a distinct hammering sound coming from the forward mount which was examined using a strobe light. It was observed that the shaft was hammering against the bushings in the shaft mounting blocks but there were no visible signs of structural degradation of the bushings or shaft.

MIL-STD-810C requires that endurance testing be conducted for 80 minutes each of the following frequencies: 11 Hz, 22 Hz, 33 Hz and 44 Hz (which are characteristics of the UH-1 Helicopter). In contrast 4.4 Hz, 13.2 Hz and 26.4 Hz are distinct characteristics of the CH-46 Helicopter.

Accordingly, testing resumed for 80 minutes in each of the following frequencies: 13 Hz, 26 Hz, 33 Hz and 44 Hz as the agreed-upon best overall combination of test environments. Testing at 4.4 Hz could not be accomplished due to the vibration equipment which has a minimum 5.0 Hz input capability.

After successfully completing the lateral (transverse) testing, longitudinal testing was initiated, again starting with 15 minute "sweeps".

Two of the four vertical direction "15 minute sweeps" were completed without any abnormalities being observed. On the third sweep sequence at 13 Hz, the cable that is connected to the "ball side" of the release assembly severed at its attachment to the container. This was caused because a "dead" weight used to simulate the RAFT pendant had created a pendulum effect, and the cable due to its short length, 2 5/16", was subjected to severe bending stress. The ball and collet was replaced with a spare and testing continued with the third and fourth sweeps being completed without further incident.

Next, the "80 minute endurance "testing was conducted at 44, 33, 26 and finally the 13 Hz cycle. Approximately 7 minutes after commencement of the 13 Hz cycle, the ball and collet cable severed again and testing was discontinued. (A redesign of the ball and collet attachment is necessary: increase the diameter of the cable from 1/16" to 3/32" and lengthen it from 2-5/16" to 5-1/2").

After the tests, the prototype system was disassembled completely and inspected for any mechanical or structural failures that might have taken place during the vibration testing. There was indication that the connecting links between the parachute shrouds and the recovery strap had been vibrating against and wearing the interior surface of the container. The inflation system was removed and found to be fully charged. A "pull test" performed on the inflation valve revealed 40 lb. pull was required to open the valve. This is acceptable since the portion of the system which falls free from the container weighs more than 125 lbs. Binding between the ball and the guide cavity of the container latch mechanism was observed. No other indications of structural or mechanical degradation were found.

As another minor design modification, the clearance between the ball and its guide cavity will be increased by 0.015."

APPENDIX A

STRUCTURAL ADEQUACY ANALYSIS OF THE RAFT SYSTEM TO HELICOPTER ATTACHMENTS

RETYPED COPY OF ORIGINAL BOEING LETTER AND REPORT
TO AIR CRUISERS COMPANY

March 14, 1979

Air Cruisers Company

Attention: T.O'Rourke, Material Manager

Subject: Air Cruisers Purchase Order 1-19644

References: (a) Statement of Work EDN 734 Revision C

*(b) Inputs to Boeing Vertol as follows:

Air Cruisers Drawings

SK-5169	Fitting, Sta. 382
SK-5170	Fitting, Sta. 350
SK-5171	Fitting, Sta. 320
SK-5308	Installation Fitting, Sta. 320
SK-5309	Installation Fitting, Sta. 350-382

(c) Pages A-3 thru A-6

Gentlemen:

The drawings of reference (b), defined as input data per Item 3A of reference (a), have been reviewed by Boeing Vertol CH-46 Airframe Stress and have been found to be unacceptable.

Outputs per Item 3A of reference (a), which ca-ls for letter type report stating load margins of safety and recommendations for modification to the aircraft if necessary, is attached.*

<u>Boeing Vertol Recommendations</u>

1. The forward mount fitting, reference (b), is unacceptable since it does not provide capability for longitudinal load introduction which per previous inputs, defines the frames capable for inplane loads only, while longitudinal loading is to be reacted by the addition of stiffeners to the lower skin between

*These drawings and attachments are not included in this final report. (Available on request from Air Cruisers Company.)

F.S. 320 and 352, reference pages 4* through 13* for load reaction by A/C structure. It is suggested the boss be an integral machined part of the fitting not welded.

2. The drawings do not depict type hardware, or modifications necessary to the aircraft, rivets to be removed and replaced so that proper edge distance, size and type fasteners such that gross net cap areas may be evaluated for strength. Interference, if any, with A/C structure and modification necessary should be evaluated and depicted on the drawings.

The bearing allowable of fasteners is determined by the thickness of material the fastener attaches to. The aircraft has several different configurations so it is necessary to know what A/C tab number you will use to determine the configuration.

Dissimilar metal contact must also be provided and specified on the drawings.

3. Question arises as to study being a feasibility study or production installation type study since production material changes, if made, will not have been tested. The strength reduction at the welds per BV SDM is 80% of the annealed values.

4. The attached analysis indicates negative margins of safety to the aircraft for the shear web at Sta. 350. This calls for the addition of a doubler. See page 24.*

Also negative margins of safety appear at the inner cap at Station 382. This could be beefed up with the fitting designed with cap reinforcements, as ears.

The stringers which react the longitudinal loads must be tied to the forward fitting, skin and frame, Station 350.

5. Drawings submitted to Boeing Vertol for stress check and recommendations should be complete as a kit drawing defining modifications to structure and installation of the fittings and drawing.

6. Attention is called to the installation of the Air Cruisers C16547 post support and the installing in the SK5308 fitting. Since this joint is loaded by socket action, stresses will be high on both the fitting and pin. Sloppy fits can result in high bearing stresses. Since all loads

come in through this joint, Boeing Vertol expresses interest in reviewing material, size and tolerance of the shaft in the fitting.

7. The attached analysis will be denoted as final pending compatibility review with the final design installation structural review.

Sincerely,

C. A. Greco
Senior Stress Engineer

CRITERIA

The supporting structure for the cargo raft system installation shall be designed in accordance with limit and ultimate design conditions as specified in Reference "A", Structural Design Criteria, Assault Transport Helicopter, which are summarized below:

DATA

Container Weight	=	135 Lbs.
Wt Mom Inertia Ixx	=	16.83 $Lb\text{-}Sec^2\text{-}In.$
Wt Mom Inertia Izz	=	44.53 $Lb\text{-}Sec^2\text{-}In.$
Wt Mom Inertia Iyy	=	17.26 $Lb\text{-}Sec^2\text{-}In.$
Drag Area	=	213 In^2
Coefficient of Drag	=	1.2

I. Maneuver Loads (Load Factors Applied Simultaneously)

A. Flight Load Conditions (Load Factors in g's)

	Type	N_x	N_y	N_z
1.	Cond. 3B AD6W External Cargo	-.4285	0	3.75
2.	Cond 3B MFCG	-.4104	0	3.827
3.	Cond 5_1 BDGW	-.4622	-.6514	4.331
4.	Cond. 3B DDGW	-.447	0	4.207
5.	Cond 5_2 BDGW MFCG 10% Fuel	-.4366	1.052	4.074
6.	Cond 3 Min. Flying Wt.	-1.8601	0	3.507
7.	Cond 5_2	-.5602	1.1148	4.298

B. Landing Load Conditions (Load Factors in g's)

	Type	N_x	N_y	N_z
8.	Cond. IC ADGW Aft Cargo	.9646	0	2.8743
9.	Cond. IVB ADGW Aft Cargo	1.060	.0782	2.6746
10.	Cond. IVB BDGW MFCG Full Fuel	.5914	-.1637	3.7968
11.	Cond. IVD BDGW MFCG Full Fuel	.6550	2.1114	3.4292
12.	Cond. IVA BDGW MFCG - 10% Fuel	-.0681	-.0855	3.4822
13.	Cond. IVD BDGW MFCS - 10% Fuel	.7242	2.4482	3.4354
14.	Cond. IC BDGW MFCG - 10% Fuel	.6311	0	3.7915
15.	Cond. IVB BDGW MFCG - 10% Fuel	.6677	-.1987	3.8595

II. Ultimate Design Conditions

A. Crash Load Conditions

	Type	N_x	N_y	N_z
16.	Litter Lds., Down	0	0	8g
17.	Litter Lds., Lateral	0	3g	0
18.	Litter Lds., Fwd.	8g	0	0
19.	Aircraft Crash, Down	0	0	8g
20.	Aircraft Crash, Lateral	0	3g	0
21.	Troop Seat Lds, Crash	8g	0	0

III. Air Load Conditions

A. Condition Fwd. Speed with Gusts

a. V_H = 146 Knots = 251 ft/sec.

b. V_G = Gust Speed = 50 ft/sec.

B. Condition Side and Vertical Gusts

a. Side Gust Load for V_G - 50 ft/sec.

b. Vertical Gust Load for V_G = 50 ft/sec.

NOTE: Gust Load Conditions are combined with Flight and Maneuver Loads

DISCUSSION:

The RAFT System Container Assy. is of a cylindrical shape attached to the bottom skin panel of the fuselage center section with a fwd. mount at F.S. 320 and an aft mount located between F.S. 350 and 382, on RH B.L. 12.0.

The fuselage center section, to which the fwd and aft mounts of the container are attached, is a semi-monocoque type structure consisting of a thin skin shell to resist shear and torsion loads, circumferential frames to distribute concentrated loading to the shell and maintain equilibrium under effects of discontinuities in skin shell structure (that is escape hatch, cargo hatch and window cutouts), and longitudinal members to resist bending and axial loads.

Primarily, ultimate applied loading governs design of frames, however, where yield loading is critical the necessary modification to give yield applied loading is made in the margin of safety calculation.

That is. Factor of $\frac{1.15}{1.50} = \frac{1}{1.305}$ is applied to ultimate load.

The attachment points are designed for the aft mounting point to be tension only while the forward mounting point is capable of axial, shear and bending forces in all axes.

Loads from the fwd container mounting point are introduced as socket loads from the 1.00 dia. shaft to the fitting.

The P_z loading is reacted as a couple by the dowel pins and sheared out to the structure thru the addition of the stiffeners to the bottom skin.

For load introduction at the aft mounting point a longitudinal member and beamed to the frames. The resulting torsional loading from the preloading of the aft mount will also be reacted by this member.

APPENDIX B

VIBRATION TEST REPORT

NADC-75353-60

DAYTON T. BROWN INC

ENGINEERING AND TEST DIVISION

CHURCH STREET, BOHEMIA, LONG ISLAND,
NEW YORK 11716 / (516) 589-6300

TEST REPORT / PROCEDURE No. DTB04R80-0350

DAYTON T. BROWN, INC. JOB No. 402697-00-000

CUSTOMER: AIR CRUISERS COMPANY
P.O. BOX 180
BELMAR, NEW JERSEY 07719

SUBJECT: VIBRATION TEST PROGRAM PERFORMED ON ONE D24805 RAFT SYSTEM, SERIAL NUMBER 0001

ATTENTION: MR. T. O'ROURKE

THIS REPORT CONTAINS: FIVE PAGES AND FOUR ENCLOSURES

PREPARED BY	G. HYLAND G. Hyland
TEST ENGINEER	G. HYLAND G. Hyland
STAFF ENGINEER	S. P. BENZA for F. Ehrman
DATE	25 MARCH 1980

THE DATA CONTAINED IN THIS REPORT WAS OBTAINED BY TESTING IN COMPLIANCE WITH THE APPLICABLE TEST SPECIFICATION AS NOTED

TABLE OF CONTENTS

1.0 ABSTRACT

This test report details the results of the vibration test program conducted on one D24805 raft system, serial number 0001, under reference (a) to the requirements of reference (c).

Results of the test are detailed in the following text.

The test item was nonoperating during testing.

Test data pertinent to this program will remain on file at Dayton T. Brown, Inc. for 90 days.

DAYTON T. BROWN INC

2.0 REFERENCES

(a) Customer Purchase Order Number 29139

(b) Dayton T. Brown, Inc. Job Number 402697-00-000

(c) Military Specification MIL-STD-810C, Method 514.2, Procedure IIC, Equipment Category d.3

3.0 ADMINISTRATIVE INFORMATION

Customer: Air Cruisers Company

Test Item Description: D24805 Raft System

Quantity Received: One

Part Number: D24805

Serial Number: 0001

Dates Received: 26 January 1980 and 19 March 1980

Dates Shipped: 26 January 1980 and 21 March 1980

Customer Representatives Present During Portions of Test:

Name	Affiliation
Mr. H. Whitney	Air Cruisers Company
Mr. D. Herman	Air Cruisers Company
Mr. J. Lore	Air Cruisers Company
Mr. N. Zubkow	Air Cruisers Company
Mr. W. Wiesemann	NADC
Mr. M. Burch	NADC

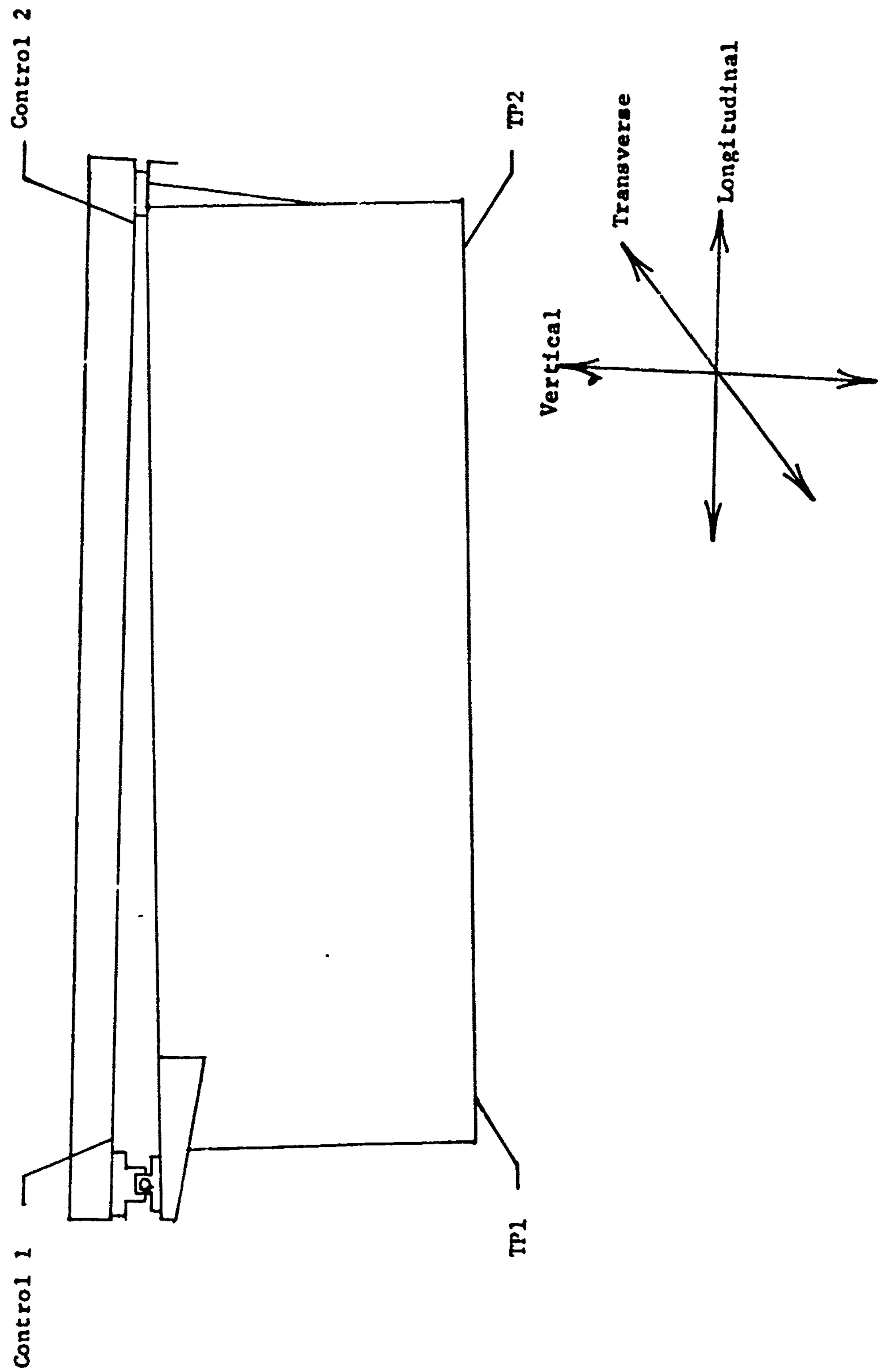
4.0 TEST PROGRAM OUTLINE

Test	Test Item Description	Results
Vibration	D24805 Raft System	See Enclosure 1

Enclosure 2

Test Axis Designation and

Accelerometer Location Sketch



TEST AXIS DESIGNATION AND ACCELEROMETER LOCATION SKETCH

Enclosure 3

Specification Deviations and Clarifications

DAYTON T. BROWN

NADC-75353-60

AUTHORIZATION FOR SPECIFICATION DEVIATION/CLARIFICATION

Date: 25 MAR 80

A specification deviation/clarification was authorized by W. WIESEMANN of NADC in reference to the following:

Job Number: 402697-00-000

Customer Purchase Order Number: 29139

Company: AIR CRUISERS COMPANY

Specification/Test Plan: MIL-STD 810C, METH. 514.2 PROC. IIC

Page 514.2-15 Paragraph: 4.6.3.3.4

Specification Requirements: FOUR RESONANT DWELLS SHALL BE CONDUCTED AT 11, 22, 33, AND 44 HZ AT THE LEVELS PER FIGURES 514.2-4D-4F

Specification Deviation/Clarification: THE FIRST TWO FREQUENCIES WERE CHANGED TO 13, AND 26 HZ AT ACCELERATION LEVELS PER FIGURE 514.2-4B

Change was received via: ____ Letter ____ Telcon ✓ Verbal

Above change was authorized by: W. WIESEMANN

Title: __________ Company: NADC

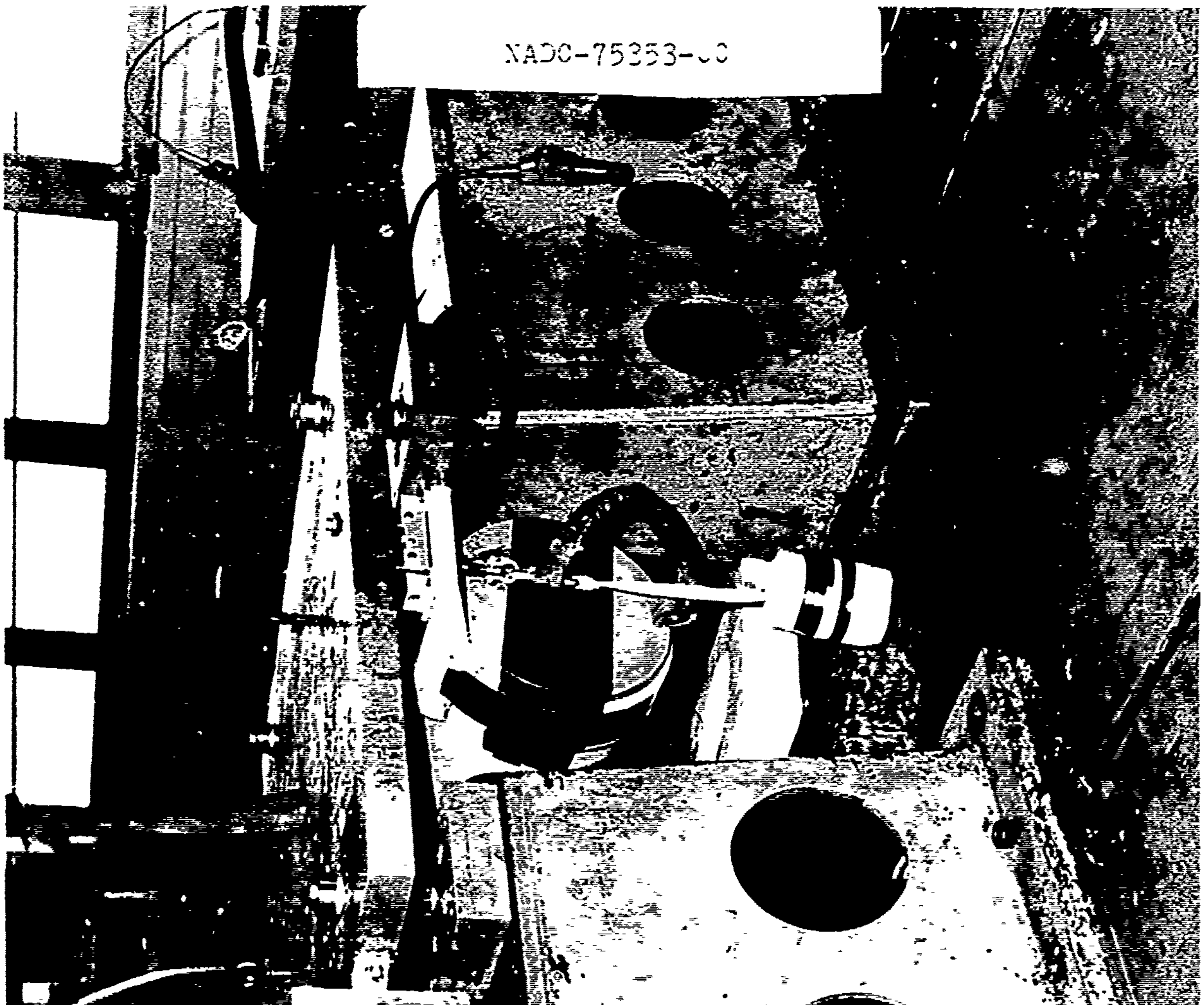
Dayton T. Brown, Inc. Project Engineer: Gary Hyland

This deviation/clarification in specification shall appear in the test report.

Lab Form 29 Rev. 3/73

Enclosure 4

Photograph



APPENDIX C

RAFT SYSTEM CONFIDENCE TESTS

RAFT SYSTEM CONFIDENCE TESTS

DATED: MARCH 2, 1978

1.0 SCOPE

2.0 APPLICABLE DOCUMENTS

3.0 GENERAL REQUIREMENTS

- 3.1 Test Facility
- 3.2 Setup
- 3.3 Instrumentation
- 3.4 Hardware/Rigging of System to Hangar Overhead

4.0 TEST PROCEDURE

5.0 SCHEDULE

6.0 TASK RESPONSIBILITIES

1.0 SCOPE

This report details the requirements for the facility, apparatus, test procedure and support for the "static drop" tests which are a part of the acceptance testing phase of the RAFT program (cargo retardation and automatic flotation system). The RAFT system will be deployed (i.e. extracted from its container and inflated) using a simulated payload under free-fall conditions to verify achievement of deployment and inflation time goals. The tests will establish confidence level of the system performance prior to the off-aircraft testing phase of the program.

2.0 APPLICABLE DOCUMENTS

NADC - RAFT Master Program Plan

NADC - Work Statement SOW 3041-21

Air Cruisers Technical Proposal - TP35239

Air Cruisers EDN's 720 (Program Plan for a RAFT System), 734 (Problem Statement), 744 (Failure Mode and Effects Analysis), 766 (RAFT System Preliminary Design Review), 768 (RAFT System Initial Design Review) and 785 (Final Design Review Action Items).

Air Cruisers Drawings D17766 (Inflation Assembly), D24740 (Retardation/Flotation Subassembly), D15143 (Container Assembly) and D24741 (RAFT Cargo Bridle Assembly).

3.0 GENERAL REQUIREMENTS

3.1 Test Facility

The static drop test are to be accomplished in "free fall" condition. Therefore, the prime consideration is altitude. The deployment altitude is to be 150 - 175 feet above the ground.

The proposed test facility is hangar number 1 at the U.S. Naval Air Station, Lakehurst, New Jersey. The hangar has a maximum ceiling height of approximately 185 ft. at the center catwalk and a ceiling height of approximately 165 ft. at the third truss catwalk. The latter is the preferred location since the ceiling height is sufficient and the landing area is clear of permanent obstructions.

The floor space required to perform the RAFT development tests is to be a conical volume which would extend from the initial deployment catwalk to the final landing area. The RAFT system installation would be approximately 154 ft. from the Southeast hangar door and 57 ft. in from the South wall. The cleared landing area would be a circular area with a radius of 57 ft. centered directly below the initial deployment site. A 20 ft. by 20 ft. area outside of the circular will be required for buildup of the test setup.

3.2 Setup

The RAFT system will be suspended from a traveler located in hangar overhead and will be mounted on a structure similar to its orientation on the aircraft. The structure will support the RAFT system by the two point attachment at the aft end of the container and by the release mechanism in the forward end of the container (See Figure C-1 for details).The payload (100 lbs.) will be retained by attaching it to the test structure and be hoisted with the RAFT system. To initiate the deployment the tether line between the payload and support structure will be severed, transferring the weight of the payload to the RAFT system release mechanism. The payload will be sand bags, which will be enclosed by a cargo net. Therefore, there will be no damage to the hangar deck due to the force of the payload upon contact.

3.3 Instrumentation

The instrumentation required to document the results of the RAFT deployment tests are as follows:

(1) Pressure Gage (1/10 psig increments) used to measure final pressure of RAFT system inflatable.

(2) Stopwatches to measure the time interval between actuation of cargo hook and ground impact.

(3) Photo coverage to document the individual tests from a variety of angles (i.e. close-up of container mechanism release/extraction sequence, full views of the deployment from the ground level and from a point on the catwalk near the system.)

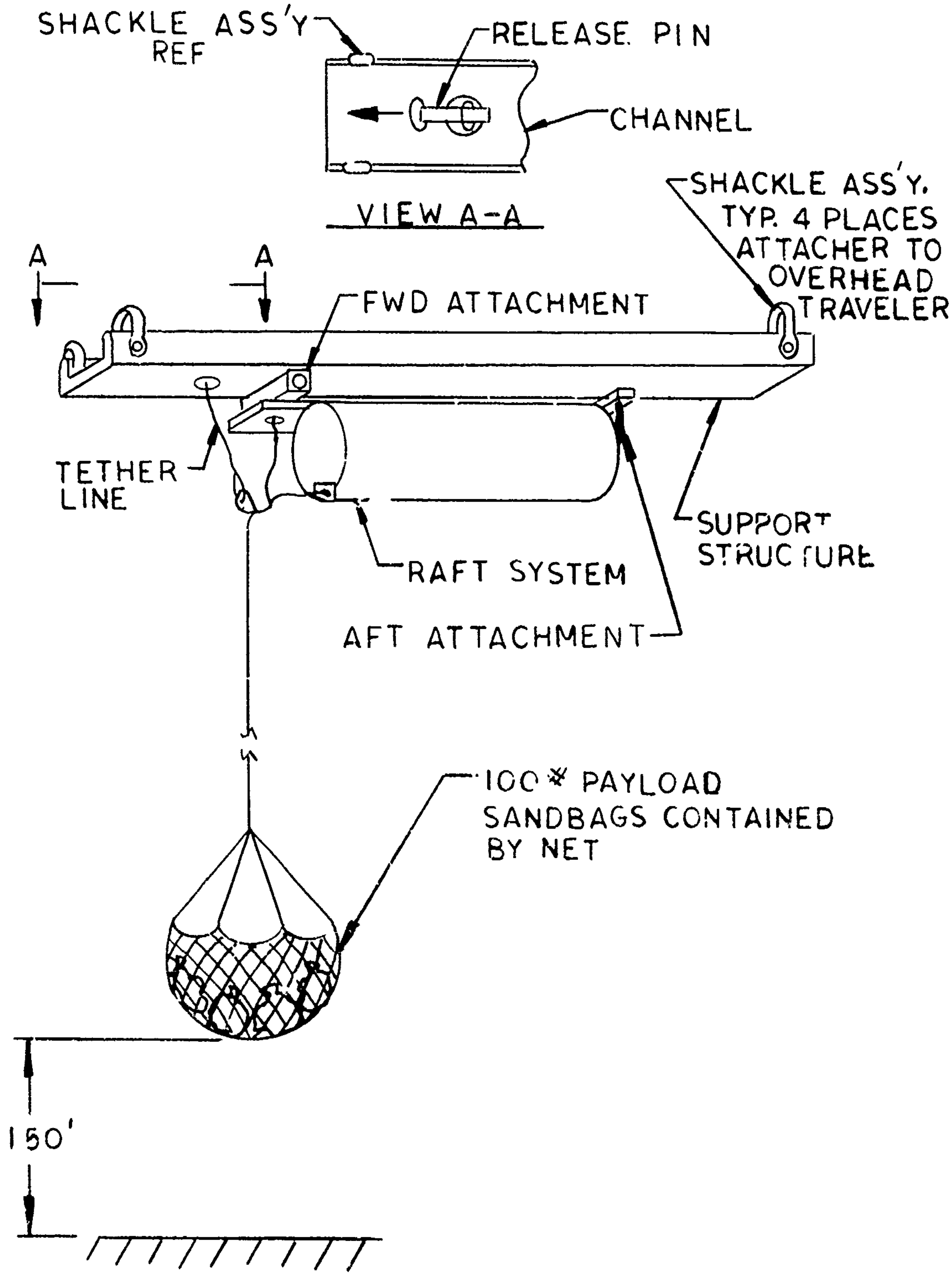


FIGURE C-1 RAFT SYSTEM CONFIDENCE TEST SETUP

3.4 Hardware/Rigging of System to Hangar Overhead

The RAFT system setup will have to be hoisted to the hangar overhead by a winch after the system is assembled on the hangar deck. The winch will have to have the capability to lift the estimated 300 lbs. up to the overheads. The hangar overhead is equipped with traveler assemblies which can accept shackles attached to the test setup support structure.

4.0 TEST PROCEDURE

The tests will consist of four deployments. All of the deployments will be performed in a similar manner. The RAFT system will be installed on the test support structure along with the payload. The system setup will be hoisted to the hangar overhead and positioned over the drop site. The payload will be detached from the support structure to transfer the payload weight to the RAFT system release mechanism. After actuation of the release mechanism the container will rotate its aft attachments and the retardation/flotation body will be extracted from the container. The inflation cycle will initiate and the parachute will deploy. Under these test conditions the parachute will be nearly fully deployed.

The first deployment will be a dry run (i.e. the inflation cylinder will be discharged) to verify that the inflatable body and parachute clear the container without fouling. The second, third and fourth deployments will be performed using a charged cylinder, in other words, a complete system.

APPENDIX D

TRIP REPORT

NASA - LRC DROP TESTS

NADC-75353-60

TRIP REPORT

DATE OF VISIT: September 11 thru September 13, 1979

FACILITY VISITED: Airplane Crash Facility
NASA Research Center
Langley, Virginia

ATTENDEES: William Wiesemann (NADC) - Technical Monitor, RAFT System Project

Tor Jansen (NADC) - Section Head, Subsystem Division, Air Vehicle Technology Dept.

Dwight McSmith (NASA) - Chief of Operations, Airplane Crash Facility NASA, Langley

Chuck Bowen - Naval Weapons Evaluation Facility, Albuquerque, N.M.

R. A. Miller - Air Cruisers

N. Zubkow - Air Cruisers

D. J. Meisner - Air Cruisers

PURPOSE: RAFT System "Confidence" Drop Tests to verify safe system operation for off-aircraft tests.

SUMMARY:

Tuesday, September 11, 1979

Interface between RAFT system mockup and the Airplane Crash Facility tower at Langley was finalized. Modifications to the mockup and NASA equipment was performed. The mockup was hoisted to the 200 ft. level and the side guide cables were adjusted to length, snubber lines and pull back lines at the 150' lever were installed (See Figure D-1 for test setup). Electrical cargo hock connection was made up and cycle tested.

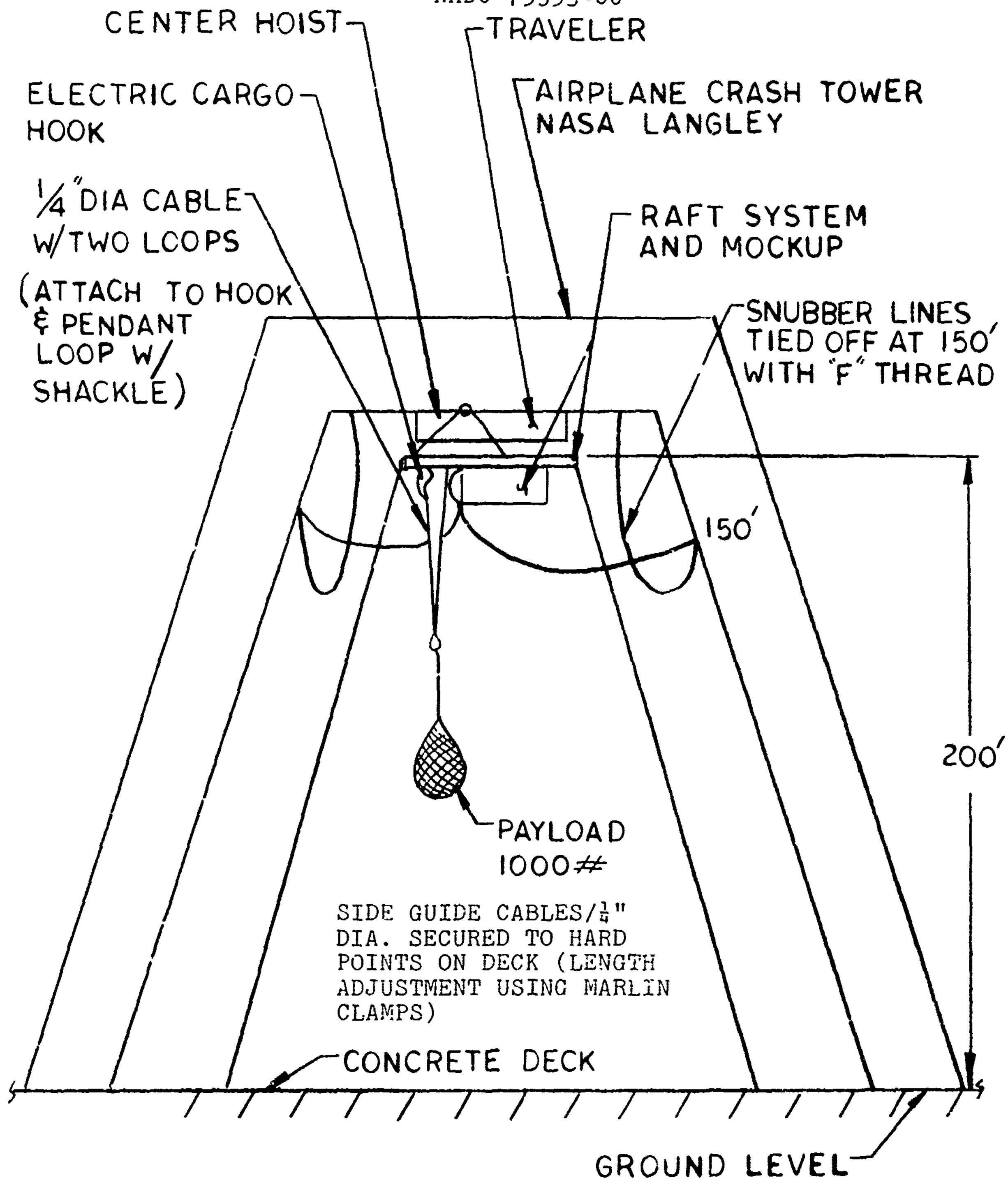


FIGURE D-1 RAFT SYSTEM TEST SETUI NASA LANGLEY

Wednesday, September 12, 1979

A preliminary test meeting was conducted to familiarize NASA personnel (riggers and camera people) with the RAFT System. The deployment test procedures were reviewed along with a discussion of possible system failure modes followed by a planned reaction sequence.

RAFT system S/N 001 was deployed using a payload of 1000 lbs. (used throughout tests). The wind velocity was 10 to 15 miles per hour from an East-North-East direction; ambient temperature was 73°F. The deployment sequence (i.e. cargo hook release, transfer of load to RAFT pendant, ball and collet release, container release mechanism rotation, container pivoting about aft attachment cables, parachute and inflatable strip from container, inflation actuation, ungee separation, full blossoming of parachute and a final inflatable pressure of 3.0 psig) was performed with no problems encountered. Full blossoming of parachute at approximately 1/3 of free fall was observed.

The second test, S/N 003 deployed satisfactorily in a 17 mile per hour wind from an East-North-East direction and a temperature of 74°F. Ground personnel observed that one leg of the inflatable seemed to lag behind the others during pressurization. As the system hung from the snubber lines one leg of the inflatable seemed to be losing rigidity.

Subsequent to lowering the inflatable from the tower, it was observed that the leg had lost pressure through a topping-off valve inadvertently left open. The remaining legs had final pressure of .75 psig.

System S/N 001 was repacked with the spare cylinder and valve. Three strand bungee was replaced due to slippage of fasteners.

Thursday, September 13, 1979

System S/N 001 was deployed in a 10 to 18 mile per hour wind from the East and at a 73°F temperature. The NASA grid back drop was used for allowing tests. The system deployed satisfactorily; full deployment of the inflatable and then quick depressurization was witnessed. After lowering the inflatable from the tower, it was observed that the bungee cord had failed prior to the "breakaway" tie and had trapped the aspirator poppet open. Also, all legs of the inflatable were depressurized, indicating that the compartment check valves did not perform the intended function.

RAFT system S/N 002 was installed on the mockup and upon checking cylinder gage pressure prior to test, the valve was determined to have leaked, resulting in a cylinder pressure of 2800 psig or about 600 psig below nominal charge pressure. NADC personnel were advised of the leakage and the system was functioned in a 10 to 18 mile per hour wind from the East with a temperature of 78°F. Results were identical to the third test (i.e. full deployment followed by complete depressurization of the inflatable caused by aspirator ingestion of a broken bungee cord and all compartment check valves failed to seal).

As a whole, the deployment "confidence" tests were successful proving the RAFT system can be deployed without endangering the helicopter its attached to. As a result of the Langley test phase investigations into bungee breakaway tie method/configuration, inflatable check valve operation and aspirator ingestion problem will be performed and results/corrective actions will be submitted.

APPENDIX E

FAILURE MODES AND EFFECTS ANALYSIS

NADC-75353-60

FAILURE MODES AND EFFECTS ANALYSIS

FOR

RAFT SYSTEM

TASK 2.1.2

PERFORMED UNDER CONTRACT NO. N62269-76-C-0273

Submitted to:

NAVAL AIR DEVELOPMENT CENTER
WARMINSTER, PENNSYLVANIA
18974

DATED: OCTOBER 7, 1976

Rev. A: Feb. 22, 1977 - Updated Failure Modes 6, 9 and 11

Rev. B: March 7, 1977 - Updated Failure Mode 3, Revised page 6

Prepared by: Thomas Pinelli
T. Pinelli
Project Engineer

Approved by: R.A. Miller
R.A. Miller
Chief Engineer

I INTRODUCTION

This failure mode and effects analysis considered the failure modes which could occur during assembly, installation on the helicopter, use during VERTREP MISSIONS, removal from the helicopter and maintenance procedures. This analysis was performed on the baseline configuration defined in Air Cruisers Technical Proposal 35239.

The hazard and hazard level by category are defined in MIL-STD-882, System Safety Program for Systems and Associated Subsystems and Equipment: Requirements for, paragraphs 3.13 and 3.14. These paragraphs are quoted below.

MIL-STD-882

3.13 Hazard. Any real or potential condition that can cause injury or death to personnel, or damage to or loss of equipment or property.

3.14 Hazard Level. A qualitative measure of hazards stated in relative terms. For purposes of this standard, the following hazard levels are defined and established: Conditions such that personnel error, environment, design characteristics, procedural deficiencies, or subsystem or component failure or malfunction:

(a) Category I - Negligible

. . . . will not result in personnel injury or system damage.

(b) <u>Category II - Marginal</u>

. . . . can be counteracted or controlled without injury to personnel or major system.

(c) <u>Category III - Critical</u>

. . . . will cause personnel injury or major system damage, or will require immediate corrective action for personnel or system survival.

(d) <u>Category IV - Catastrophic</u>

. . . . will cause death or severe injury to personnel, or system loss.

Conclusions and recommendations for modification of the RAFT system design that were determined as a result of this analysis are given in Section III.

II ANALYSIS DISCUSSION

FAILURE MODE	FAILURE CAUSES	DESIGN CONSIDERATIONS TO MINIMIZE POSSIBI
1) Relief device ruptures during reservoir charging operation.	a) Overcharge 1) Weighing scale error 2) Incorrect tare weight 3) Human error	Stored gas reservoir is equipped with a fr relief device rated at 90% of the reservoi (test pressure is 5000 psig). Consider addition of pressure gage on asse reference check against charging by weight latter provides the additional benefit of readiness check" capability.
	b) Defective Relief Device	Highly unlikely, isolated reliability of b by many thousands of high pressure reservo which use 3HT reservoirs with burst disc r identical to that used in the RAFT system.
2) Stored gas reservoir ruptures during charging operation.	Reservoir charged in excess of 90% of test pressure and relief overpressure device does not rupture until burst level pressure of reservoir is reached (i.e. in excess of 6667 psig)	Reservoir is manufactured and tested to DO which requires 100% hydrostatic testing to 5000 psig and periodic retest at 3 year in unlikely failure since charge facility mus Reservoir should be installed within vesse taining reservoir (shrapnel) should ruptur
3) Inadvertent RAFT deployment	a) Inadvertent reservoir discharge during packing of RAFT system caused by inflation valve lanyard cable snag during packing of RAFT system (or cable is tensioned in error).	a) Consider addition of safety lock on inf prevent valve from opening. Safety loc ible after system is packed to permit
	b) RAFT pendant snags on adjacent obstacles during VERTREP hookup or drop-off.	b) Pendant will be stored in helicopter t loop. Six (6) foot length of reefed "] pendant intercepts inadvertent applica loads to pendant during cargo handling crewmen with knives to cut free riggin able, if necessary.
	c) Human error during transfer of RAFT pendant during VERTREP hookup and disconnect.	c) Highly unlikely that 250 lb. activatio posed on release mechanism during pend

ODE & EFFECT ANALYSIS - RAFT SYSTEM

DERATIONS TO MINIMIZE POSSIBILITY OF FAILURE	FAILURE EFFECT	FAILURE CATEGORY
eservoir is equipped with a frangible disc e rated at 90% of the reservoir's test pressure re is 5000 psig). ition of pressure gage on assembly to provide a eck against charging by weight procedure. The des the additional benefit of a "pre-flight eck" capability.	a) Relief device performed	Category I Hazard Classification
ely, isolated reliability of burst disc is proven sands of high pressure reservoir installations T reservoirs with burst disc relief devices that used in the RAFT system.	b) No hazard provided reservoir is restrained during charging.	
manufactured and tested to DOT 3HT specification es 100% hydrostatic testing to test pressure of d periodic retest at 3 year intervals. A highly lure since charge facility must malfunction also. ould be installed within vessel capable of con- rvoir (shrapnel) should rupture occur.	May cause personnel injury.	Category IV Hazard Classification
addition of safety lock on inflation lanyard to alve from opening. Safety lock must be access- r system is packed to permit system to be armed.	a) System distends - possible damage to inflatable/container and injury to personnel.	a) Category III Hazard Classification
ill be stored in helicopter to eliminate external x (6) foot length of reefed "restrained slack" of intercepts inadvertent application of tensile pendant during cargo handling. Provide ground ith knives to cut free rigging/puncture inflat- necessary.	b) Loss of RAFT system function. Inflatable body damage may result, ground crewmen may become entangled in rigging.	b) Category III Hazard Classification
likely that 250 lb. activation force will be in- release mechanism during pendant transfer.	c) Loss of RAFT system function. Inflation body damage may result, ground crewmen may become entangled in rigging.	c) Category III Hazard Classification

2

FAILURE MODE & EFFECT ANALYSIS -

FAILURE MODE	FAILURE CAUSES	DESIGN CONSIDERATIONS TO MINIMIZE POSSIBI
3) (Continued)		
	d) Improper (too long) sling is used (substitute part for MK-105) or improper RAFT bridle (too short)	d) Adherence to proper operational procedu this cause.
	e) Pendant is reefed with wrong safety tie (too strong) which causes container release to separate before reef ties break.	e) Adherence to proper operational procedu this cause.
4) Aft container attachment breaks loose from container or aircraft attachment hardware during ferrying of cargo.	Structural failure of aircraft swiveling attachment assembly.	The interface attachment is considered a and therefore must be designed with a high Samples will be tested to destruction as ance Test Program of the RAFT system.
5) Breakaway container attachment breaks loose inadvertently during ferrying of cargo	Interface structural failure	The interface attachment is considered a and therefore is designed with a high fac Samples will be tested to destruction as Acceptance Test Program of the RAFT system
6) Container fails to release.	a) Ball and collet fail to separate.	a) Ball and collet are suspended by a 1/ cable, nominal breaking strength 500 lb collet do not separate the cable will system will be permitted to proceed to of deployment.
	b) Shaft rotating pin shears.	b) Shaft rotating pin dia. is 5/16", ultimate single shear of 6730 lbs. The shaft pin bal and collet adapter by a 3/16" dia. f having a nominal breaking strength of 370 pin and the cable strength exceed max. ca lbs. Thus probability of this failure mod eliminated.

/

MODE & EFFECT ANALYSIS - RAFT SYSTEM

SIDERATIONS TO MINIMIZE POSSIBILITY OF FAILURE	FAILURE EFFECT	FAILURE CATEGORY
e to proper operational procedures will minimize se.	Cargo must be jettisoned.	Category II Hazard Classification.
e to proper operational procedures will minimize se.	Cargo must be jettisoned.	Category II Hazard Classification
ace attachment is considered a critical assembly ore must be designed with a high factor of safety. ll be tested to destruction as part of the Accept- Program of the RAFT system.	RAFT system is rendered non-functional.	Category II Hazard Classification if drop off of cargo can be made. Category IV if cargo is jettisoned since cargo would be lost.
ace attachment is considered a critical assembly ore is designed with a high factor of safety. ll be tested to destruction as part of the Test Program of the RAFT system.	No failure effect. RAFT container hangs suspended by the swivel attachment.	Category II Hazard Classification
nd collet are suspended by a 1/16" dia. flexible ominal breaking strength 500 lbs. If ball and do not separate the cable will break and the will be permitted to proceed to the next stage loyment. ting pin dia. is 5/16", ultimate strength and ar of 6730 lbs. The shaft pin is attached to the ollet adapter by a 3/16" dia. flexible cable ominal breaking strength of 3700 lbs. Both the cable strength exceed max. cargo weight of 3000 probability of this failure mode is essentially	RAFT system will not deploy.	Category IV Hazard Classification

2

FAILURE MODE & EFFECT ANALYSIS -

DESIGN CONSIDERATIONS TO MINIMIZE POSSIB

FAILURE MODE	FAILURE CAUSES	
6) (Continued)	c) Shaft seized in bearing supports. d) Lugs seized in bearing supports.	c) & d) Attachment cables are capable of up to approx. 3700 in.-lbs. Based on the geometry, the max. payload of 3000 lbs. p capability for "torquing" the latch mecha approx. 3000 in.-lbs., considerable desig is provided. Also considerable actuated jettison mechanism for entire RAFT System (i.e. "pickle" container).
7) Parachute fails to open after jettisoning of cargo (inflation occurs however).	a) Damaged components: Parachute shroud lines and fittings entangled lines, torn shroud caused by abuse during packing or snagging on container cover.	a) Consider jettisonable container cover possibility of hangups. Use of qualif personnel for maintenance is mandatory
	b) RAFT system not packed properly.	b) Detailed packing procedures are provide these procedures will minimize this cau
8) Snagging of parachute, shroud lines, RAFT recovery cable, etc. during jettisoning.	External projections on helicopter, obstruction in container due to prior damage.	Location of system under helicopter precl landing gear, etc. Pre-flight checkout of condition. Consider automatic RAFT system capability as discussed in 6).
9) RAFT system deploys but does not fully inflate or inflate at all.	a) Zero or low, pressure in the primary inflation air reservoir. 1. Relief device rupture due to prior exposure to temperature above service limit. 2. Leakage 3. Improper charging	a) Provide visual indication of pressure
	b) Aspirator malfunction Ingestion float fabric or other matter thereby preventing proper sealing of the check valve.	b) The air aspirator is located on the in such a position so as to eliminate the ingestion and is positioned within the as defined in the packing procedure so possibility of ingestion of material o Aspirator has only one moving spring 1 secondary inlet check poppet (a simple

DE & EFFECT ANALYSIS - RAFT SYSTEM

DERATIONS TO MINIMIZE POSSIBILITY OF FAILURE

	FAILURE EFFECT	FAILURE CATEGORY
chment cables are capable of transmitting 3700 in.-lbs. Based on the mechanism max. payload of 3000 lbs. provides the r "torquing" the latch mechanism to in.-lbs., considerable design margin Also considerable actuated backup anism for entire RAFT System " container). ettisonable container cover to eliminate y of hangups. Use of qualified, trained for maintenance is mandatory.	Cargo will be dropped without full retardation. Cargo damage possible if cargo is jettisoned from an altitude higher than 150 feet.	Category II Hazard Classification
cking procedures are provided. Adherence to edures will minimize this cause. ystem under helicopter precludes snagging etc. Pre-flight checkout of container onsider automatic RAFT system jettison discussed in 6).	RAFT system will not deploy Cargo will not be jettisoned.	Category IV Hazard Classification
sual indication of pressure as discussed in 1).	Possibility of cargo loss.	Category IV Hazard Classification if insufficient flotation results, otherwise Category I
pirator is located on the inflation body in ition so as to eliminate the chances of fabric and is positioned within the packaged system in the packing procedure so as to eliminate y of ingestion of material on deployment. has only one moving spring loaded part - the inlet check poppet (a simple, reliable device).		

V

FAILURE MODE & EFFECT ANALYSIS -

FAILURE MODE	FAILURE CAUSES	DESIGN CONSIDERATIONS TO MINIMIZE POSSIBIL
9) (Continued)	c) Inflation valve malfunction.	c) Device is a proven design. The ball val utilized is based on the precedent of m valves in operational use on inflatable ment for periods of up to fifteen years
	d) Puncture in inflation body.	d) Flotation body has 5 independent compart valve in each of the 4 legs does not all the legs to be lost should the sphere be Punctures in a leg would cause a partial from the sphere. Flotation subsystem is 167% of design buoyancy requirements and of two cells would not cause the system below 3000 lbs. Flotation subsystem use 2 ply, fabric to minimize susceptibility Container designed to eliminate puncture tainer is located remotely from cargo.
	e) Human error, arming of inflation valve lanyard omitted.	e) Pre-flight check point for correct armi provided.
10) Locator light does not function.	Strobe light not installed. Strobe light burned out. Dead batteries. Misrigged actuation lanyard.	Periodic maintenance/replacement of batte useful life limitations is necessary. De procedure/check list must be implemented.
11) Recovery interconnection sub-assembly separation.	RAFT recovery cable broken. Internal RAFT bridle ruptured. RAFT bridle cargo hook disengaged.	The recovery interconnection subassembly withstand well in excess of the maximum p opening load. Use of a positive closing, cargo hook will eliminate accidental carg engagement. Shroud lines provide redunda

ODE & EFFECT ANALYSIS - RAFT SYSTEM

DERATIONS TO MINIMIZE POSSIBILITY OF FAILURE	FAILURE EFFECT	FAILURE CATEGORY
a proven design. The ball valve configuration is based on the precedent of more than 15,000 operational use on inflatable survival equip- periods of up to fifteen years.		
body has 5 independent compartments. A check ach of the 4 legs does not allow the gas in o be lost should the sphere be punctured. in a leg would cause a partial loss of gas phere. Flotation subsystem is designed for sign buoyancy requirements and a complete loss ls would not cause the system buoyancy to drop lbs. Flotation subsystem uses heavyweight, ric to minimize susceptibility to puncture. designed to eliminate puncture hazards. Con- located remotely from cargo.		
t check point for correct arming of lanyard is		
ntenance/replacement of batteries well within limitations is necessary. Detailed assembly eck list must be implemented.	Nite time recovery search operations inhibited.	Category I Hazard Classification
interconnection subassembly to be designed to ll in excess of the maximum peak parachute . Use of a positive closing, self-locking ill eliminate accidental cargo hook dis- Shroud lines provide redundant load paths.	Possibility of cargo loss.	Category IV Hazard Classification

V

III CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the preceding analysis, it is concluded that the RAFT system baseline design approach is sound. The potential hazards which have been identified can be eliminated or effectively controlled by incorporating the following modifications, additional features and precautionary measures:

a) Charging of the high pressure reservoir should be conducted with the device installed (clamped) within a protective housing that is capable of containing the reservoir and/or valve, should rupture occur.

b) Addition of a direct reading gage to permit visual verification of state of readiness of the system during operation and also to provide a check that the cylinder is correctly charged during maintenance buildup of the system.

c) Incorporation of a positive safety lock into the reservoir mounted inflation valve to prevent inadvertent discharge of the reservoir during handling and assembly of the system.

d) Incorporation of a backup automatically actuated (by the pilot) release mechanism into the RAFT container-to-helicopter attachments to permit jettisoning the RAFT system on the helicopter side of the interface.

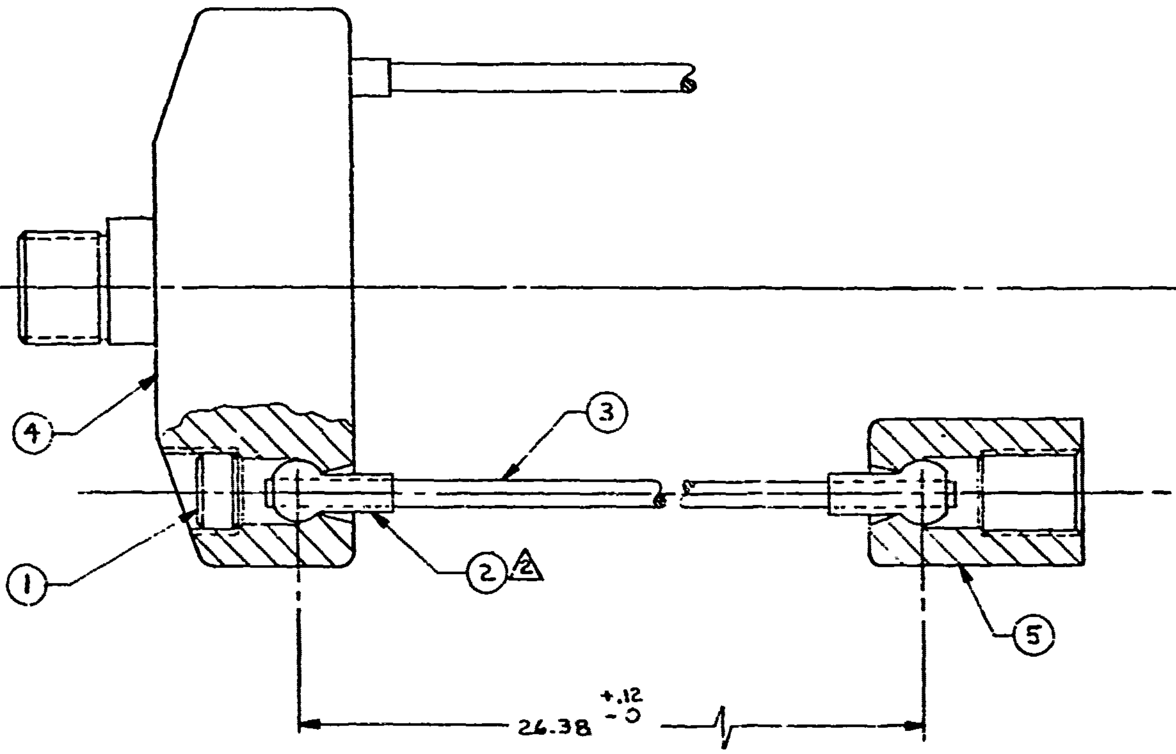
e) Incorporation of a jettisonable RAFT container cover that falls with the parachute transition line.

APPENDIX F

DRAWINGS

C16567
16D17194
D24805
ERD17783
ERD17806
ERD24739
ERD24740
ERD24741
ERD24752

E.C.N.



NOTES
1.
△2
3

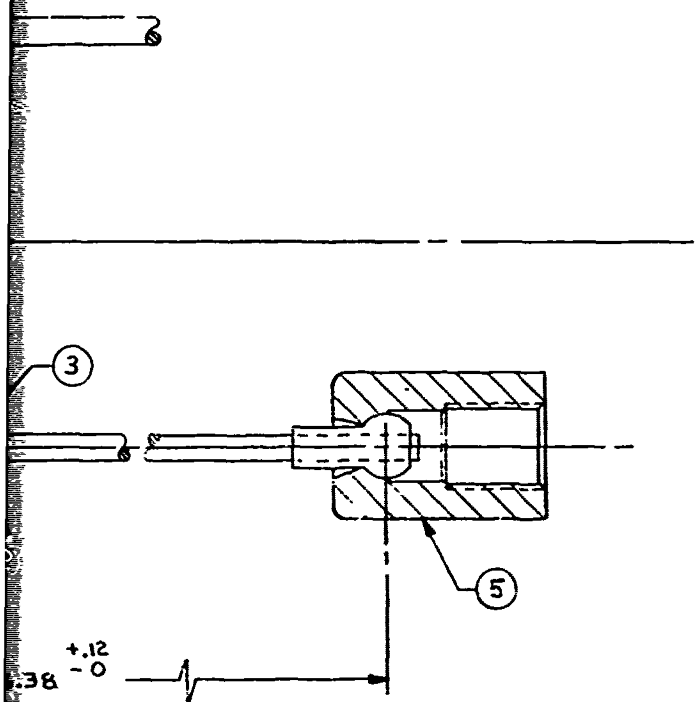
3	5	C16569-1		NU
1	4	C16565-1		FIT
AR	3	——		WI
6	2	MS20664C8		BA
3	1	E16570-1		SC
QTY REQD	ITEM NO.	PART NO.	SYM	
-131	← ASSYS			

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS X ±
DECIMALS XX ±
DECIMALS XXX ±
FRACTION ±
ANGLES ±
SEE STANDARD PRACTICE

SIGN

-131	D17766	
DASH	NEXT ASSY	USED ON

REVISIONS				
E.C.N.	SYM	DESCRIPTION	DATE	APPROVED
	A	EARLY RELEASE G.J.L. 11-30-77	12/5/77	



NOTES:

1. MIL-W-83420 TYPE I, COMP. B.
2. SWAGE ITEM 2 TO ITEM 3 IN ACCORDANCE WITH MS 20664
3. IDENTIFY WITH AIR CRUISERS CO. P/N PER MIL-STD-130, PARA. 4.

QTY REQD	ITEM NO.	PART NO.	SYM	DESCRIPTION	CODE IDENT	MATERIAL	SPECIFICATION	UNIT WT
3	5	C16569-1		NUT, RECOVERY				
1	4	C16565-1		FITTING, TRANSITION MALE				
AR	3	———		WIRE ROPE 1/4 DIA.			SEE NOTE 1	
6	2	MS20664C8		BALL END		CRES		
3	1	C16570-1		SCREW, SOCKET JAM				
-101 ← ASSYS				LIST OF MATERIAL				

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS .X ±
DECIMALS .XX ±
DECIMALS .XXX ±
FRACTION ±
ANGLES ±
SEE STANDARD PRACTICE #11

SIGNATURES	DATES
DR G. J. LOPES	11-30-77
CHK	12/5/77
WPD ENG	
	12/2/77
APP	
APP	
APP	
APP	12/5/77
DESIGN ACTIVITY	
OTHER ACTIVITY	

AIR CRUISERS COMPANY
BELMAR, NEW JERSEY

DWG TITLE: BRIDLE ASSEMBLY RECOVERY

SIZE	CODE IDENT NO.	DWG NO.
C	70167	C16567

SCALE NONE | WT EST. 10 LBS. | SHEET 1 OF 1

DASH	NEXT ASSY	USED ON
-101	D17766	

A | C16567

AIR CYLINDERS PART NO.	CUBIC IN. CAPACITY MIN.	NOMINAL WEIGHT OF AIR CHARGE	WEIGHT OF UNCHARGED CYLINDER LBS. (MAX.)	END CONTOUR	A. MAX. O.D. DIE SIZE	B. MAX. LENGTH	C. MAX. MIN. NECK DIA.	D. MIN. NECK LENGTH	W. KIDDE PART NO.	PRESSED STEEL TANK CO. PART NO.	TAVCO INC. PART NO	REMARKS
16D17194-1	50		[illegible]	Ellip. [illegible]	3.64	[illegible]	[illegible]	.75	276655	[illegible]	—	
16D17194-2	75	.679	3.25	Spher.	3.566	11.06	1.730 1.710	.75	245147	—	—	
16D17194-3	100	.905	4.12	Spher	4.155	10.33	1.730 1.710	.75	244134	—	—	
~~16D17194-4~~	~~125~~	~~[illegible]~~	~~5.9~~	Spher.	~~4.155~~	~~12.60~~	1.74 1.70	~~.75~~	~~243977~~			△2 MANUFACTURE DISCONTINUED
16D17194-5	150	1.358	[illegible]	Ellip. or Spher.	[illegible]	[illegible]	1.74 1.70	[illegible]	245426	[illegible]	—	
16D17194-6	175	1.581	7.25	Spher.	5.21	12.38	1.74 1.70	.75	245148	—	—	
16D17194-7	200	1.810	8.94	Ellip. or Spher.	5.370	13.25	1.74 1.70	.63	245149	[illegible]	—	
16D17194-8	225	2.036	9.69	Ellip. or Spher.	5.320	14.53	1.74 1.70	.63	243978	2111501	—	
16D17194-9	275	2.49	11.19	Ellip. or Spher.	5.320	17.12	1.74 1.70	.63	273975	[illegible]	—	
16D17194-10	425	3.85	18.32	Ellip.	6.210	12.89	1.730 1.710	.63	274645	2113001	—	
16D17194-11	125	1.131	5.40	Spher.	3.560	16.75	1.74 1.70	.63	249273	2111806	—	
16D17194-12	330	2.98	12.87	Ellip. or Spher.	5.460	[illegible]	1.730 1.710	.63	271733	2111901	—	
16D17194-13	500	—	19.75	Spher.	6.820	[illegible]	1.730 1.710	.63	243915	2111401	—	△8
16D17194-14	150	—	5.63	Spher.	4.155	13.88	1.74 1.70	.75	245427	—	—	
16D17194-15	300	—	12.06	Ellip. or Spher.	5.320	18.06	1.74 1.70	.63	243820	2111504	—	
16D17194-16	600	—	22.0	Spher.	6.800	22.12	1.730 1.710	.63	280058	2111402	—	
16D17194-17	750	—	26.50	Spher.	6.800	26.62	1.730 1.710	.63	280059	2111404	—	
16D17194-18	1130	—	41.75	Spher.	7.50	32.25	1.730 1.710	.63	280060	211320	—	
16D17194-20	650	—	23.56	Spher.	6.800	23.68	1.730 1.710	.63	280198	2111403	—	
16D17194-21	1000	—	35.0	Spher.	7.754	28.00	1.72	.75	24 224	—	—	
16D17194-22	425	—	17.7	Spher.	6.77	17.12	1.72	.75	—	—	—	
16D17194-23	900	—	36.0	ELLIP. OR SPHER.	7.36	27.38	1.730 .710	.12	—	2111604	23711972	△6 USED ON D30311 NEXT ASSY D17468
16D17194-24	1000	—	38.5	SPHER	7360	30.13	1.730 1.710	.63	—	2111603	—	
16D17194-25	265	—	10.88	ELLIP.	5.33	16.125	1.730 1.710	.63	—	2111510	—	
16D17194-26	125	—	5.8	ELLIP. OR SPHER.	4.345	12.125	1.730 1.710	.80	—	2113801	—	△13
16D17194-131	500	—	19.75	ELLIP.	6.820	18.87	1.730 1.710	.63	—	2111701	—	△8

NOTES CONT'D:

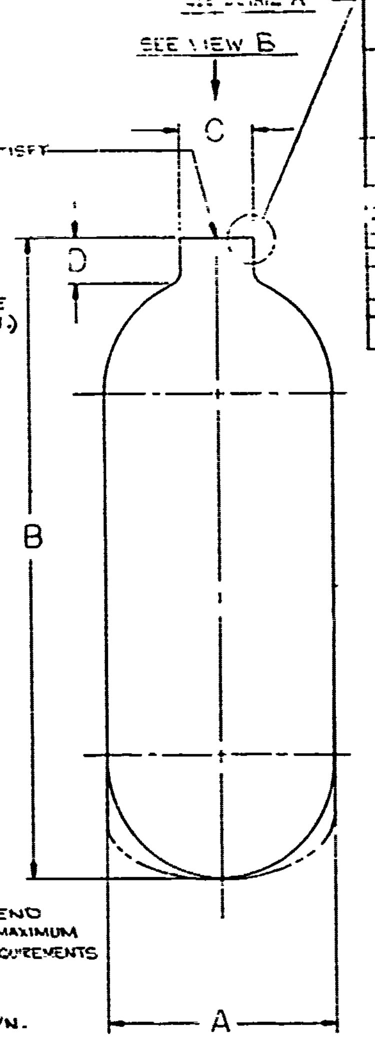
△10 MAXIMUM VOLUME IS 5 PERCENT GREATER THAN VOLUME LISTED.

△11 W.KIDDE CYLINDER IS AN ACCEPTABLE ALTERNATE TO PRESSED STEEL TANK CO. CYLINDER.

△12 PRESSED STEEL TANK CO. CYLINDER IS AN ACCEPTABLE ALTERNATE TO W.KIDDE CYLINDER.

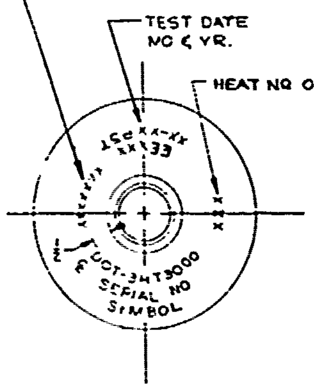
△13 DASH 26 SUPERSEDES & OBSOLETES DASH 4.

REMARKS
MANUFACTURE DISCONTINUED
[8]
USED ON D30311 NEXT ASSY D17468
[5]



THREADED FITTINGS TO SATISFY ALL REQUIREMENTS OF MS 33649, EXCEPT THAT THREAD LENGTH TO BE .70 MINIMUM AFTER COMPLETION OF FINISHING OPERATION PER NOTES 3,6 & 7, (VERIFICATION TO BE MADE BY USE OF GAGE NO. 79-5G-1)

NOTE: ELLIPTICAL END RESULTS IN MAXIMUM ENVELOPE REQUIREMENTS



VIEW B

E.C.N.	STR	REVISIONS DESCRIPTION	DATE	APPROVED
	D	[illegible] PREVIOUS [illegible]		
	P	[illegible]		
	T	INCORPORATED ECN [illegible] WAS [illegible] 5.875 [illegible]		
	U	CHANGED [illegible] ASSY [illegible]		
	V	[illegible] SEE ECN FOR DETAILS. ADDED [illegible]		
	AA	[illegible]		
		[illegible]		
	EE	-11 DIM A WAS 3.556 -24 DIM A WAS 7.375 -24 WEIGHT WAS 33.0 LBS [illegible]		
	AK	INC ADV [illegible]		
	AM	INC. ADV. ECN (AL) & ADDED DASH 26		

"NOTES CONT'D. ZONE A-8"

9. AFTER COMPLETION OF ALL MANUFACTURING OPERATIONS, THREADED FITTINGS TO BE COATED WITH DOW-CORNING DC-4 COMPOUND AND SEALED WITH GASKETED CAP.

[8] -131 IS AN ACCEPTABLE ALTERNATE TO -13 EXCEPT FOR L1011 P/N'S D17468-503, -507, -509 & -511.

7. ALTERNATE ACCEPTABLE INTERNAL FINISH: PHOSPHATE COAT PER TT-C-490, TYPE I. RESIN COAT WITH MIL-R-3043 PER MIL-C-5056.

6. FINISH, EXTERNAL: PHOSPHATE COAT PER TT-C-490 TYPE I ONE COAT RED OXIDE PRIMER PER TT-P-664. TWO COATS DULL BLACK LACQUER PER TT-L-32.

5. ONLY THE ITEMS DESCRIBED ON THIS DWG WHEN PROCURED FROM THE VENDOR LISTED HEREON IS APPROVED BY AIR CRUISERS CO. BELMAR, N.J. FOR USE IN THE APPLICATION SPECIFIED HEREON. A SUBSTITUTE ITEM SHALL NOT BE USED WITHOUT PRIOR TESTING AND APPROVAL BY AIR CRUISERS CO BELMAR, N.J.

4. APPROVED SOURCE OF SUPPLY:
   1) WALTER KIDDE – 675 MAIN ST. BELLEVILLE, NEW JERSEY
   2) PRESSED STEEL TANK – 1439 SOUTH 66TH ST. MILWAUKEE, WISCONSIN
   3) TAVCO INC. – 20500 PRAIRIE ST. CHATSWORTH, CALIFORNIA

3. FINISH: UNLESS OTHERWISE SPECIFIED INTERIOR – GRIT BLAST & 2-COATS OF HERESITE. EXTERIOR – 2-COATS BLACK LACQUER OVER ZINC CHROMATE PRIMER

2. SERVICE PRESSURE 3000 P.S.I.
   TEST PRESSURE 5000 P.S.I.
   BURST PRESSURE 6667 P.S.I.

1. CYLINDER CONFORMS TO D.O.T. -3HT SPEC.

NOTES:

SOURCE CONTROL DWG.

QTY REQD	ITEM NO	PART NO.	STR	DESCRIPTION	CODE IDENT	MATERIAL	SPECIFICATION

LIST OF MATERIAL

AIR CRUISERS COMPANY, BELMAR, NEW JERSEY

CYLINDERS D.O.T. 3HT-3000 NON-WIRE WOUND

SIZE D | CODE IDENT NO. 70167 | DWG NO. 16D17194

SCALE | WT | SHEET 1 OF

V

4

NOTES:

A. INFLATED VOLUME PER. SYSTEM:

B. BOUOYANCY: 5000 LBS.

C. NOMINAL OPERATING PRESSURE: 1.5 P.S.I.G.

D. INFLATION TIME (EST.): 1.5 SEC. NOM.

E. RATE OF DESCENT: 3000 LBS, 100 F.P.S.

F. TOTAL SYSTEM WGT: 135 LBS.

G. R.A.F.T. SYSTEM IS MANUFACTURED USING PARTS LIST EDR 50-102.

REVISIONS				
E.C.N	SYM	DESCRIPTION	DATE	APPROVED
	A	DEVELOPEMENT RELEASE 6-9-80		

QTY REQD	ITEM NO	PART NO.	SYM	DESCRIPTION	CODE IDENT	MATERIAL	SPECIFICATION	UNIT WT
1	4	D24740-101		RETARDATION/FLOTATION SUB-ASS'Y.				
1	3	D17766-101		INFLATION ASS'Y.				
1	1	D15145-101		CONTAINER, ASS'Y.				

← ASSYS

LIST OF MATERIAL

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS .X ±
DECIMALS .XX ±
DECIMALS .XXX ±
FRACTION ±
ANGLES ±
SEE STANDARD PRACTICE #11

-101	FINAL	FINAL
REQD	NEXT ASSY	USED ON

SIGNATURES | DATES

DESIGN ACTIVITY

DIST.

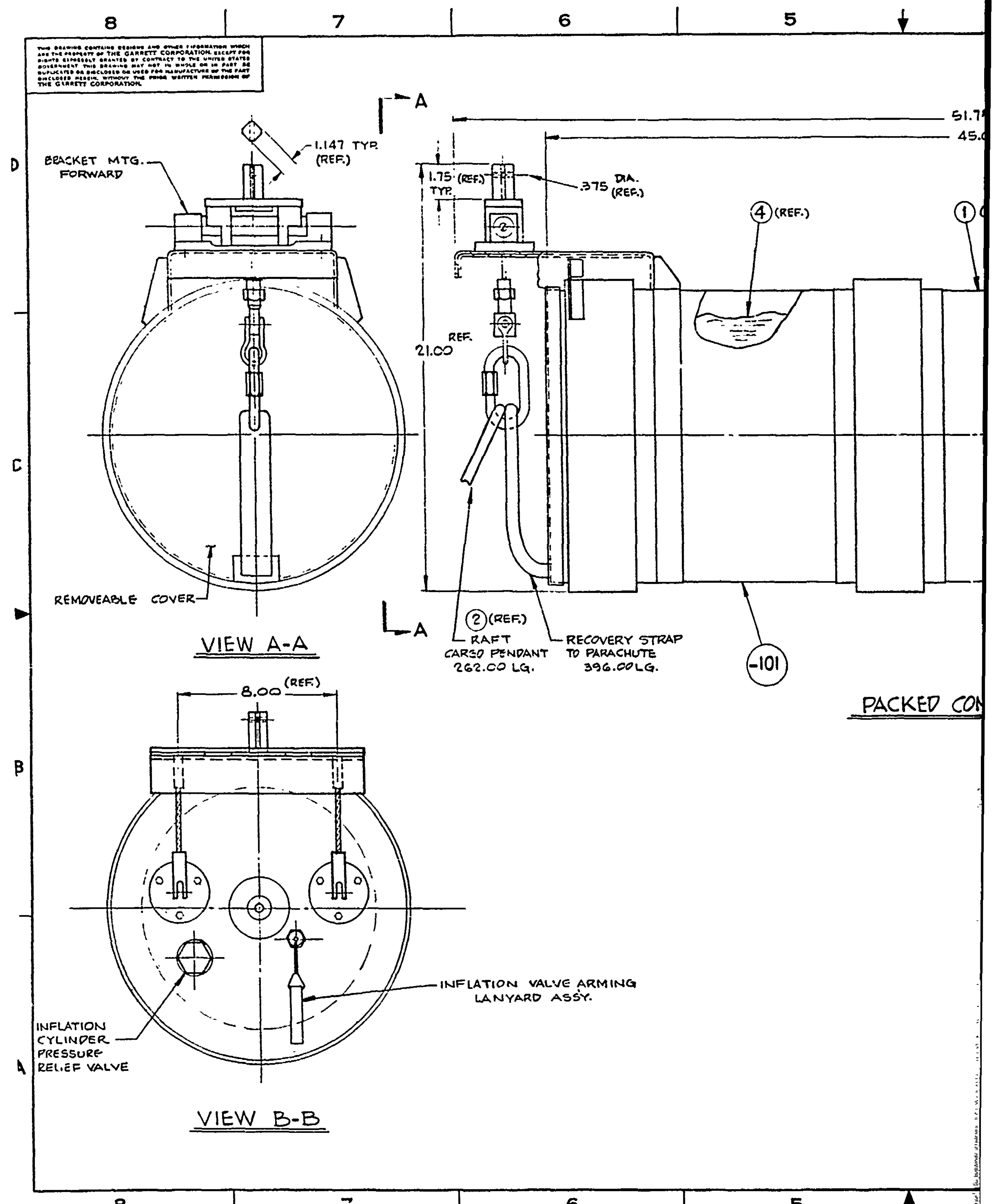
AIR CRUISERS COMPANY
BELMAR, NEW JERSEY

DWG TITLE

R.A.F.T. SYSTEM

SIZE	CODE IDENT NO.	DWG NO.
D	70167	D24805

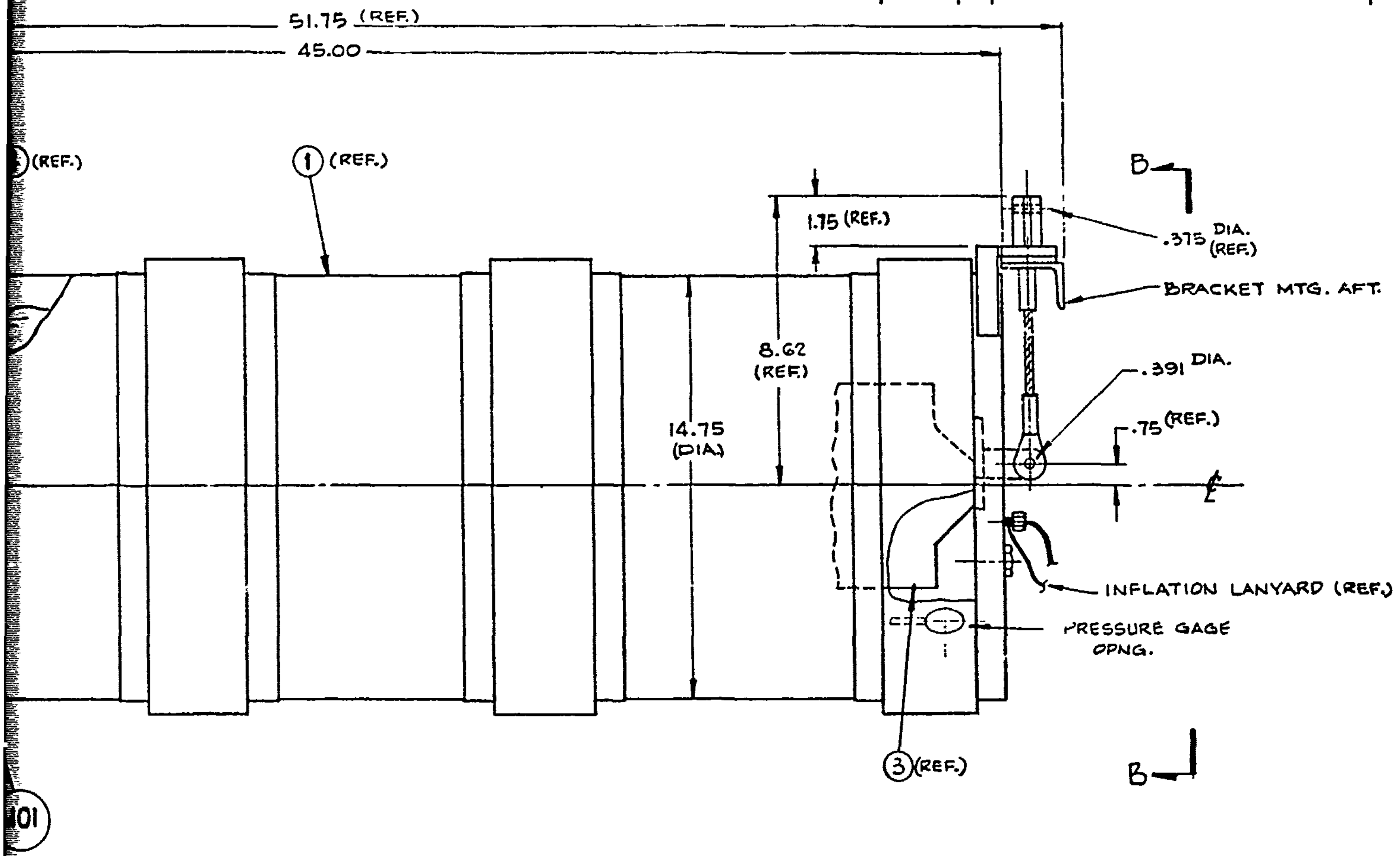
SCALE | WT | SHEET 1 OF 3


8
7
6
5
D
C
B
A
BRACKET MTG. FORWARD
1.147 TYP. (REF.)
REMOVEABLE COVER
VIEW A-A
A
1.75 (REF.) TYP.
.375 DIA. (REF.)
51.7
45.0
4 (REF.)
1
REF. 21.00
2 (REF.)
RAFT CARGO PENDANT 262.00 LG.
RECOVERY STRAP TO PARACHUTE 396.00 LG.
-101
PACKED CON
8.00 (REF.)
INFLATION VALVE ARMING LANYARD ASSY.
INFLATION CYLINDER PRESSURE RELIEF VALVE
VIEW B-B

5	4	3	2	1

REVISIONS

E.C.N.	SYM	DESCRIPTION	DATE	APPROVED



PACKED CONFIGURATION

QTY REQD	ITEM NO	PART NO.	SYM	DESCRIPTION	CODE IDENT	MATERIAL	SPECIFICATION	UNIT WT
← ASSYS				LIST OF MATERIAL				

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS .X ±
DECIMALS .XX ±
DECIMALS .XXX ±
FRACTION ±
ANGLES ±
SEE STANDARD PRACTICE #11

SIGNATURES / DATES

AIR CRUISERS COMPANY
BELMAR, NEW JERSEY

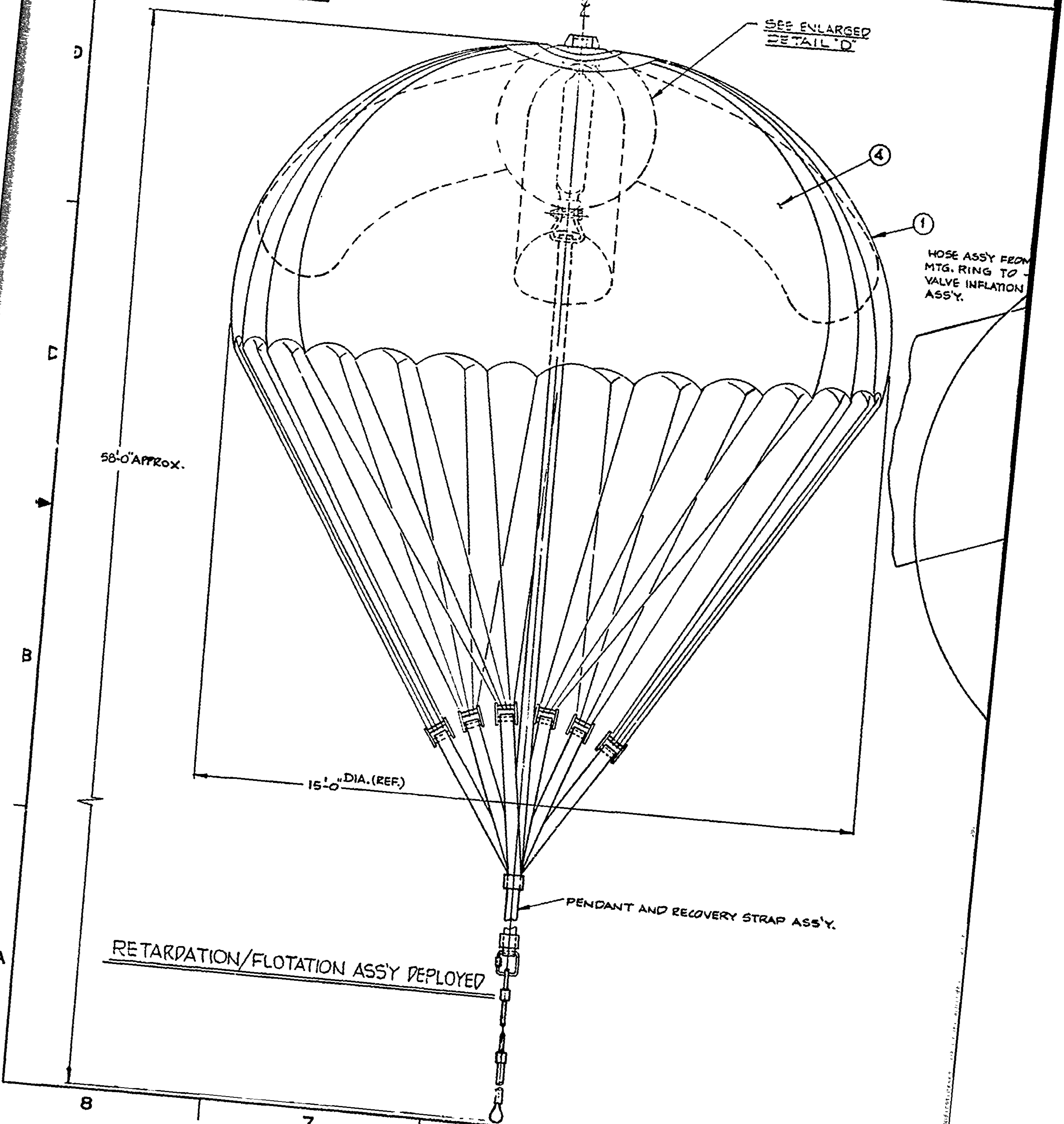
TITLE: R.A.F.T. SYSTEM

SIZE	CODE IDENT NO.	DWG NO.
D	70167	D24805

SCALE | WT | SHEET 2 OF 3

REQD	NEXT ASSY	USED ON

5	4	3	2	1

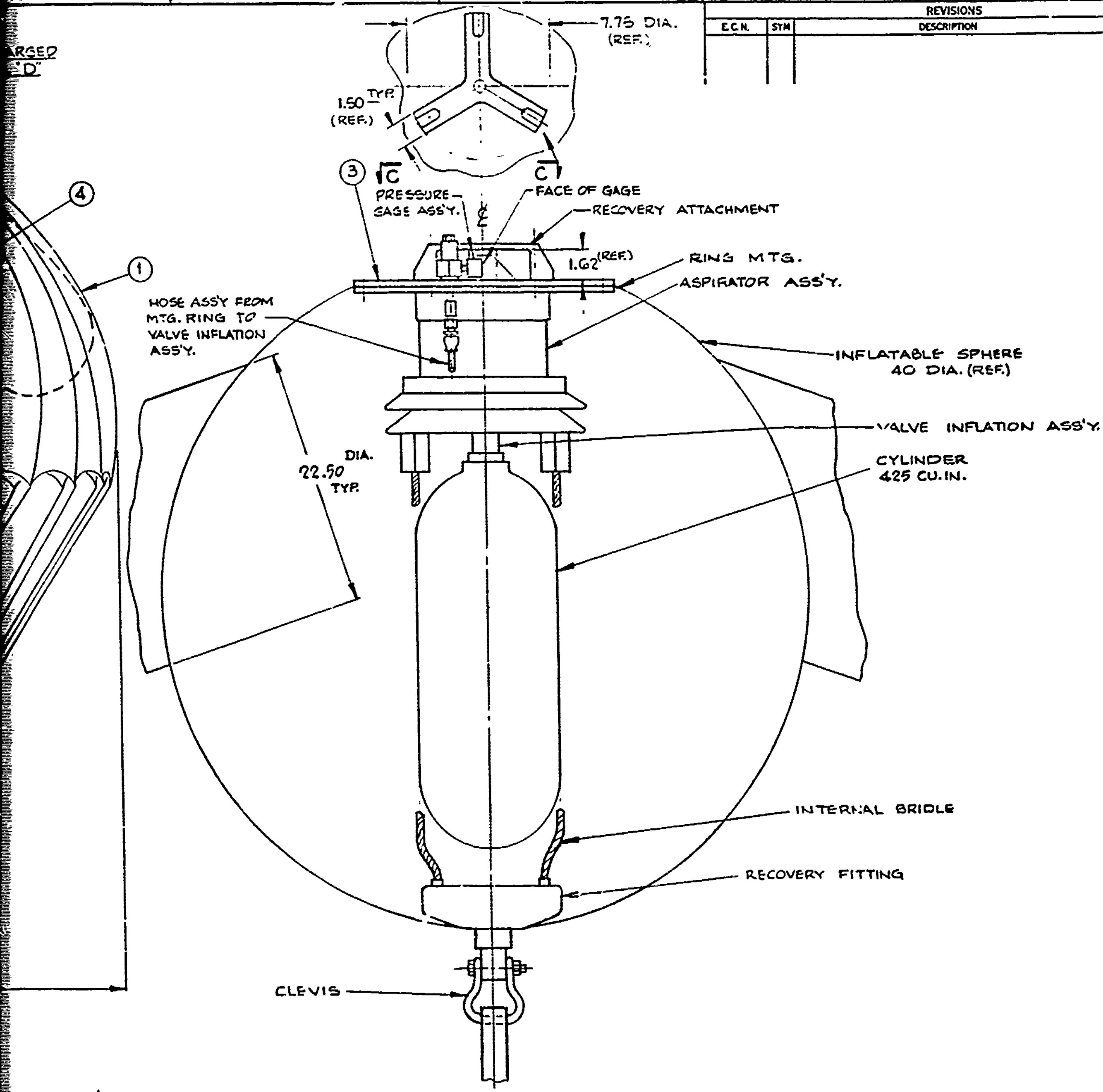


RETARDATION/FLOTATION ASS'Y DEPLOYED

	5	4	3	2	1

REVISIONS

E.C.N.	SYM	DESCRIPTION	DATE	APPROVED



DETAIL "D"

FLOTATION ASS'Y. SPHERE WITH INFLATION ASS'Y

QTY REQD	ITEM NO	PART NO.	SYM	DESCRIPTION	CODE IDENT	MATERIAL	SPECIFICATION	UNIT WT
← ASSYS				LIST OF MATERIAL				

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON
DECIMALS . ±
DECIMALS .XX ±
DECIMALS .XXX ±
FRACTION ±
ANGLES ±
SEE STANDARD PRACTICE #11

SIGNATURES	DATES
DFT	
CHK	
DFG ENG	
APP	
APP	
APP	
APP	
APP	
DESIGN ACTIVITY	
OTHER ACTIVITY	

REQD	NEXT ASSY	USED ON

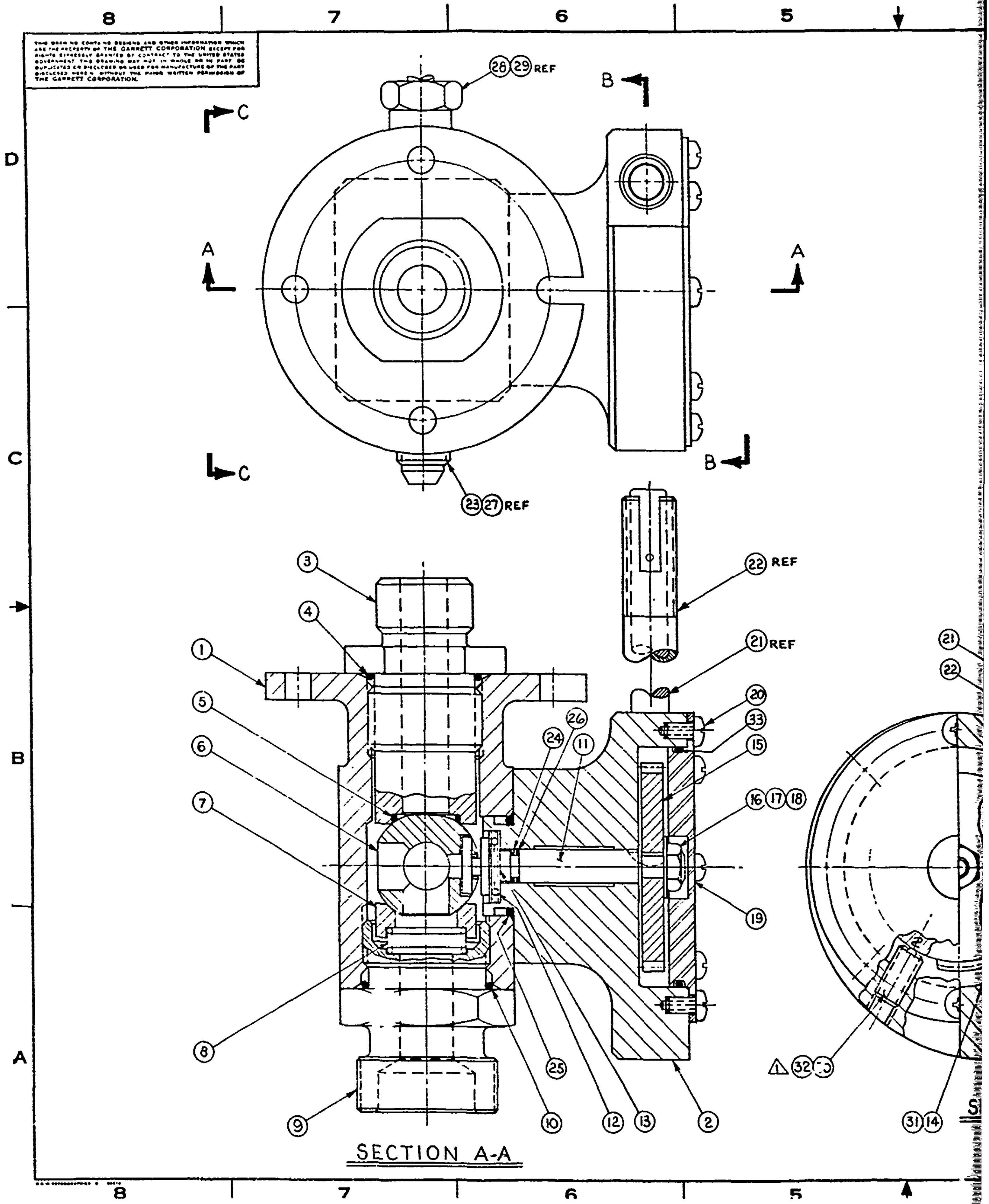
AIR CRUISERS COMPANY
BELMAR, NEW JERSEY

DWG TITLE
R.A.F.T. SYSTEM

SIZE	CODE IDENT NO.	DWG NO.
D	70167	D24805

SCALE	WT	SHEET 3 OF 3

	5	4	3	2	1


8
7
6
5
D
C
B
A
28 29 REF
B
C
A
A
B
C
23 27 REF
22 REF
21 REF
3
4
1
5
6
7
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9
10
11
12
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14
15
16 17 18
19
20
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24
25
26
31 14
32
33

SECTION A-A

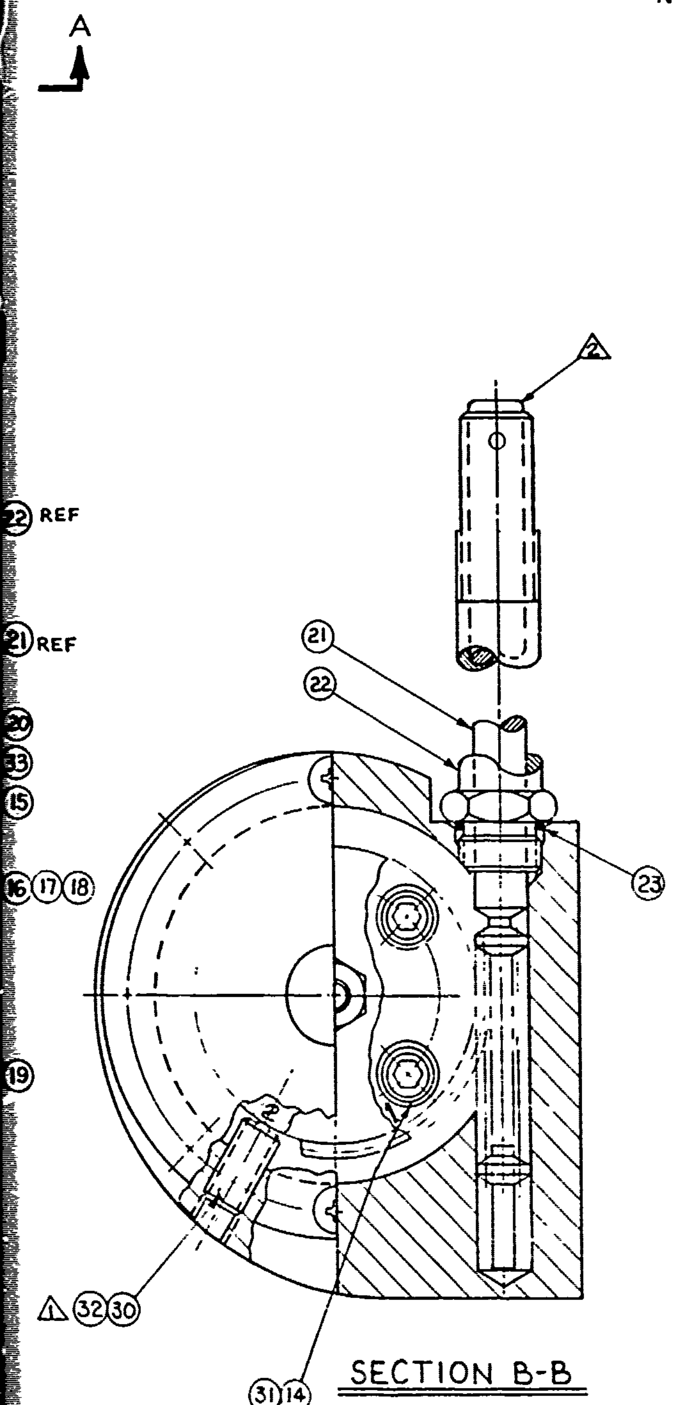
5 4 3 2 1

REVISIONS				
E.C.N.	SYM	DESCRIPTION	DATE	APPROVED
	A	EARLY RELEASE JR 6-6-77		
	B	ITEM 13 QTY REQD WAS 3, ADDED NOTES 1 & 2, ADDED ITEM NO.S 26 & 33 TO FIELD OF DWG., ITEM 27 B17817-1 WAS MS24392J5, ITEM 30 SSM-54 WAS X-14N, 01226 WAS 01599. ADDED ITEM NO. 33 TO L/M WOG 11-1-77	11/1/77	J.P.

NOTES:

1. ADJUST PLUNGER TO .025 CLEARANCE BETWEEN PLUNGER END & FACE OF GEAR WHEN PLUNGER IS OPPOSITE NO."2" ON GEAR.

2. TO ARM VALVE, ENGAGE FIRST TOOTH OF RACK WITH SLOT MARKED "1" ON GEAR.



SECTION B-B

QTY REQD				ITEM NO	PART NO.	SYM	DESCRIPTION	CODE IDENT	MATERIAL	SPECIFICATION	UNIT WT
			1	25	B14056-910		"O" RING				
			1	24	B14056-008		"O" RING				
			2	23	B14056-905		"O" RING				
			1	22	C17781-1		GUIDE, VALVE ACTUATING RACK				
			1	21	C17780-1		RACK, VALVE ACTUATING				
			6	20	MS-51957-26		SCREW, MACH, PAN HD				
			1	19	B17779-1		COVER, PINION HOUSING				
			1	18	79NTM-02		NUT, HEX, SELF LOCKING	72962			
			1	17	MS9549-09		WASHER, PLAIN, FLAT				
			1	16	MS9848-01		KEY, WOODRUFF				
			1	15	C17778-1		PINION, VALVE ACTUATING				
			4	14	MS16996-15		SCREW, CAP, SOC HD				
			2	13	B17777-1		PLATE, THRUST				
			1	12	B17776-1		BEARING, THRUST				
			1	11	C17775-1		SHAFT, PINION				
			1	10	B14056-914		"O" RING				
			1	9	B17774-1		FITTING, CYLINDER				
			1	8	B17773-1		SPRING, COMPRESSION				
			1	7	B17772-1		GUIDE, SPRING				
			1	6	C17771-1		BALL, VALVE				
			1	5	B17770-1		SEAT, BALL				
			1	4	B14056-912		"O" RING				
			1	3	B17769-1		ADAPTER, VALVE DISCHARGE				
			1	2	D17766-1		HOUSING, PINION				
			1	1	D17767-1		HOUSING, VALVE				
				← ASSYS			LIST OF MATERIAL				

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS ± DECIMALS ± DECIMALS ± FRACTIONS ± ANGLES ± SEE STANDARD PRACTICE

SIGNATURES	DATES
DFTS	
CHK	
APP	77

AIR CRUISERS COMPANY
BELMAR, NEW JERSEY

VALVE ASSEMBLY, INFLATION

SIZE	CODE IDENT NO.	DWG NO.
D	70167	ER D17783

SCALE NONE WT TBD SHEET 1 OF 2

DASH	NEXT ASST	USED ON
101		

5 4 3 2 1

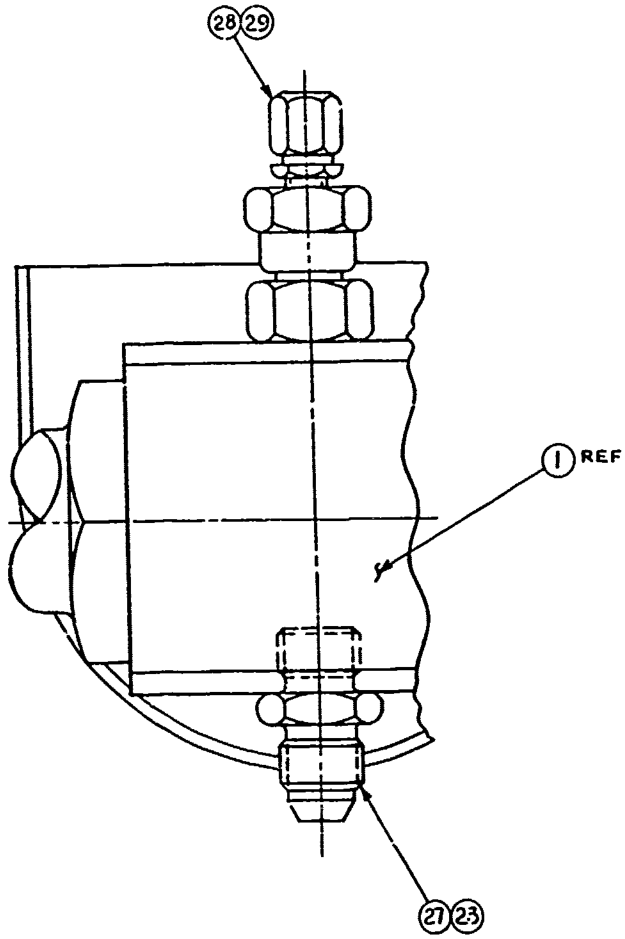
8	7	6	5

D

C

B

A



VIEW C-C

8	7	6	5

ECN	SYM	DESCRIPTION	DATE	APPROVED
	*	SEE SHEET 1 FOR LATEST REV		

QTY REQD				ITEM NO.	PART NO.	SYM	DESCRIPTION	CODE IDENT	MATERIAL	SPECIFICATION	UNIT WT
			1	33	B14056-033		"O" RING				
			AR	32	242		COMPOUND, THREAD LOCKING	05972		MIL-S-224773	
			4	31	MS-35333-73		WASHER, LOCK				
			1	30	SSM-54		BALL PLUNGER	01226			
			1	29	MS-24690		"O" RING				
			1	28	MS-28889-1		VALVE, AIR, HP, CHARGING				
			1	27	217317-1		UNION, FLAIRED TUBE				
			1	26	MS-28774-[illegible]		RING, BACKUP				
				← ASSYS			LIST OF MATERIAL				

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS .X ±
DECIMALS .XX ±
DECIMALS .XXX ±
FRACTION ±
ANGLES ±
SEE STANDARD PRACTICE

DASH	NEXT ASSY	USED ON

SIGNATURES | DATES

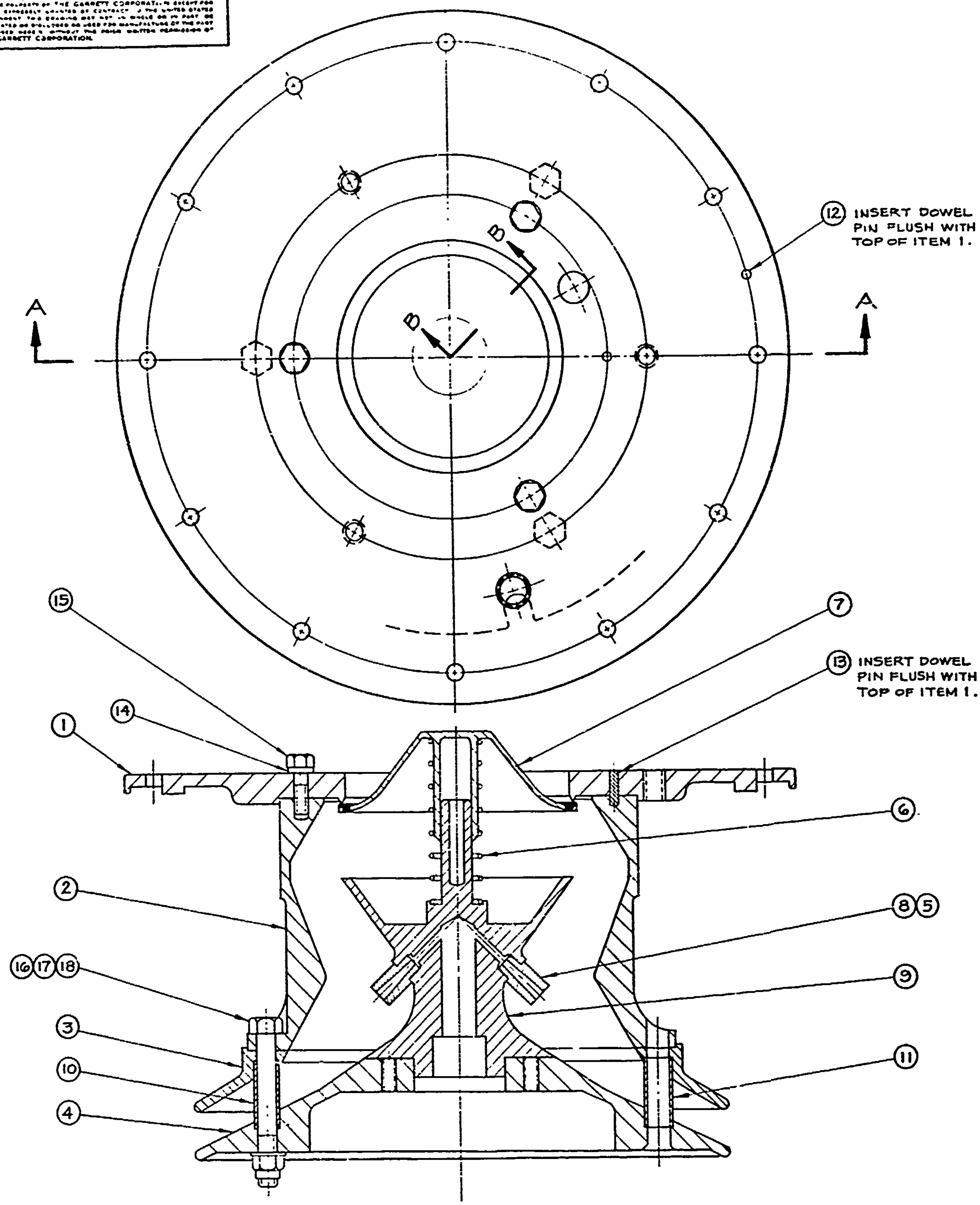
AIR CRUISERS COMPANY
BELMAR, NEW JERSEY

DWG TITLE
VALVE ASSEMBLY, INFLATION

SIZE	CODE IDENT NO.	DWG NO.
D	70167	ERD17783

SCALE NONE | WT | SHEET 2 OF 2

2


A
A
B
B
12 INSERT DOWEL PIN FLUSH WITH TOP OF ITEM 1.
13 INSERT DOWEL PIN FLUSH WITH TOP OF ITEM 1.
15
7
1
14
6
2
8 5
16 17 18
9
3
11
10
4

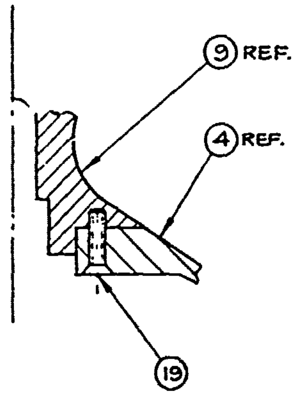
SECTION A-A

E.C.N	SYM	DESCRIPTION	DATE	APPROVED
	A	EARLY RELEASE DM 7-5-77		

REVISIONS

(12) INSERT DOWEL PIN FLUSH WITH TOP OF ITEM 1.

A



SECTION B-B

(7)

(13) INSERT DOWEL PIN FLUSH WITH TOP OF ITEM 1.

(6)

(8)(5)

(9)

(11)

QTY REQD	ITEM NO	PART NO.	SYN	DESCRIPTION	CODE IDENT	MATERIAL	SPECIFICATION
4	19	MS24693-C274		SCREW, MACHINE, FLAT CSK			
3	18	MS9785-33		BOLT, MACHINE, HEX. HD.			
3	17	MS9549-11		WASHER, FLAT			
3	16	MS51922-14		NUT, SELF-LOCKING			
3	15	MS35307-3X		SCREW, CAP, HEX. HD.			
3	14	25W		COLLAR, LOCK-SEAL	04865		
1	13	MS16555-25		PIN, DOWEL			
1	12	MS16555-29		PIN, DOWEL			
3	11	C17805-3		SPACER, ASPIRATOR			
3	10	C17805-1		SPACER, ASPIRATOR			
1	9	D17800-1		NOZZLE RING			
12	8	C17801-1		NOZZLE, ASPIRATOR			
1	7	C17803-1		VALVE, POPPET			
1	6	B17804-1		SPRING, COMPRESSION			
A/R	5	242		COMPOUND, THREAD LOCKING	05972		MIL-S-22473
1	4	D17802-1		LOWER INTERIOR RING			
1	3	D17799-1		LOWER EXT. CYL. BODY			
1	2	D17798-1		UPPER EXT CYL BODY			
1	1	D17797-1		TOP PLATE			

- ← ASSYS

LIST OF MATERIAL

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS .X ±
DECIMALS .XX ±
DECIMALS .XXX ±
FRACTION ±
ANGLES ±
SEE STANDARD PRACTICE

SIGNATURES | DATES

AIR CRUISERS COMPANY
BELMAR, NEW JERSEY

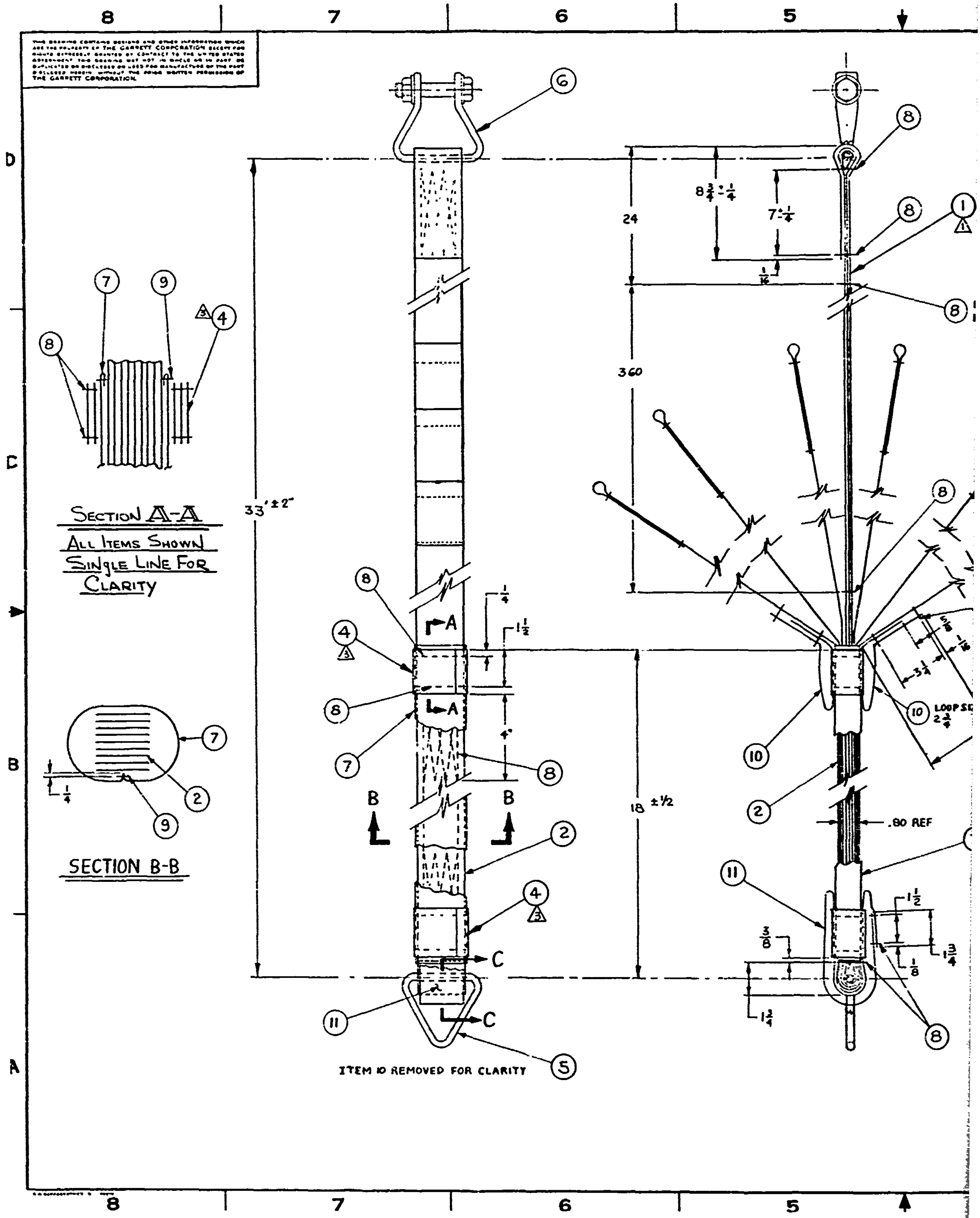
TITLE

ASPIRATOR ASSEMBLY

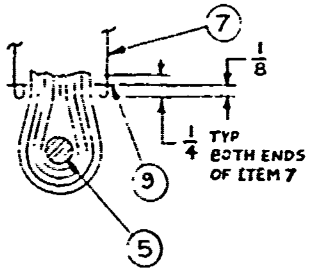
SIZE	CODE IDENT NO.	DWG NO.
D	70167	ER D17806

SCALE NONE | WT TBD | SHEET 1 OF 1

DASH	NEXT ASSY	USED ON
101	TBD	TBD

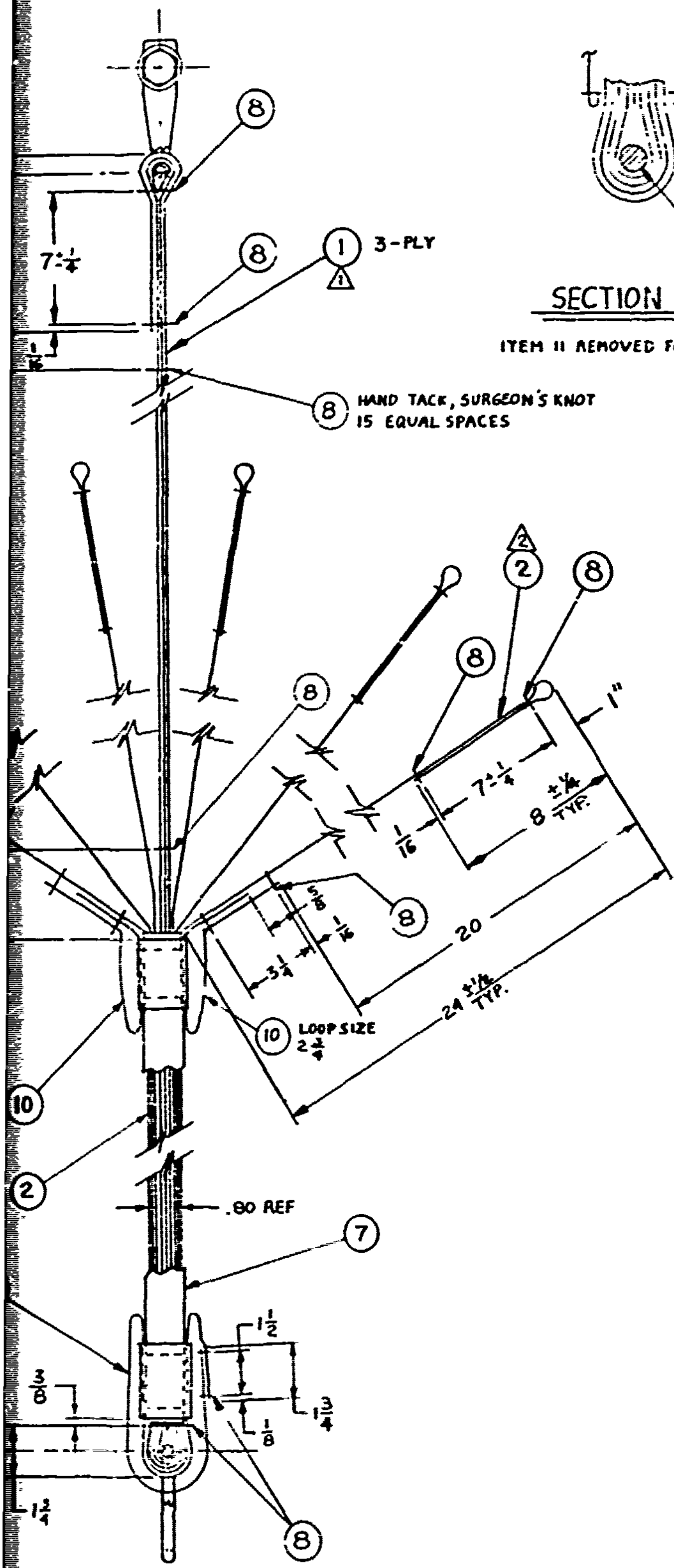

8
7
6
5
D
C
B
A
SECTION A-A
ALL ITEMS SHOWN SINGLE LINE FOR CLARITY
SECTION B-B
33' ± 2"
24
360
18 ± 1/2
8 3/4 ± 1/4
7 ± 1/4
1/16
1/4
1 1/2
4"
.80 REF
LOOP SE
3 1/4
5/8
3/8
1/8
1 3/4
ITEM 10 REMOVED FOR CLARITY

ECN	SYM	DESCRIPTION	DATE	APPROVED
	A	EARLY RELEASE	[illegible]	[illegible]
MC 76'6	B	REVISED DIMS & CALLOUTS. SEE ECN FOR DETAILS	[illegible]	[illegible]
	C	ADDED SECTION C-C , REVISED SECTION A-A. SEE ECN FOR DETAILS.	[illegible]	[illegible]



SECTION C-C

ITEM 11 REMOVED FOR CLARITY



Notes:

1. MIN. BREAKING STRENGTH : 16,500 LBS.
2. MIN. BREAKING STRENGTH : 5,500 LBS.
3. 2½ TURNS MIN.
4. MANUFACTURED BY : U.S. FORGECRAFT CORP. FT. SMITH, ARKANSAS 72902
5. ALL ENDS OF WEBBING ARE TO BE HEAT FUSED.
6. SEWING SHALL CONFORM TO FEDERAL SPECIFICATION 751 .
7. IDENTIFY WITH AIR CRUISERS CO. PART NO. PER MIL-STD-130 PARA. 4.

QTY REQD	ITEM NO.	PART NO.	SYM	DESCRIPTION	CODE IDENT	MATERIAL	SPECIFICATION	UNIT WT
1	11	D24739-11		WEBBING, 1.62" WD. X 18.75 LG.		TYPE 12, COND. R	MIL-W-4088	
2	10	D24739-10		WEBBING, 1.62" WD x 11.50" LG.		TYPE 12, COND. R	MIL-W-4088	
A/R	9	———		THREAD, SIZE "E", COLOR O.D.			V-T-295	
A/R	8	———		THREAD, SIZE "FF", O.D.			V-T-295	
1	7	———		SLEEVE, CLOTH, 5.50 WD x [illegible] LG, CLOD		TYPE III	MIL-C-7219	
1	6	MS70087-1		CLEVIS				
1	5	3012	4	HOIST LINK, 1 1/4"				
2	4	D24739-4		WEBBING, 1.75 WD X 7.65 LG.		TYPE 8, COND R	MIL-W-4088	
3	2	D24739-2		TRANSITION STRAP, 1.75 WD X [illegible] LG, WHT		TYPE 7, COND R	MIL-W-4088	
1	1	D24739-1		RECOVERY STRAP, 1.75 WD X [illegible] LG, WHT.		TYPE 7, COND R	MIL-W-4088	

← ASSYS — LIST OF MATERIAL

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS .X ± DECIMALS .XX ± DECIMALS .XXX ± FRACTION ± 1/16 ANGLES ±

SEE STANDARD PRACTICE #11

SIGNATURES	DATES

AIR CRUISERS COMPANY
BELMAR, NEW JERSEY

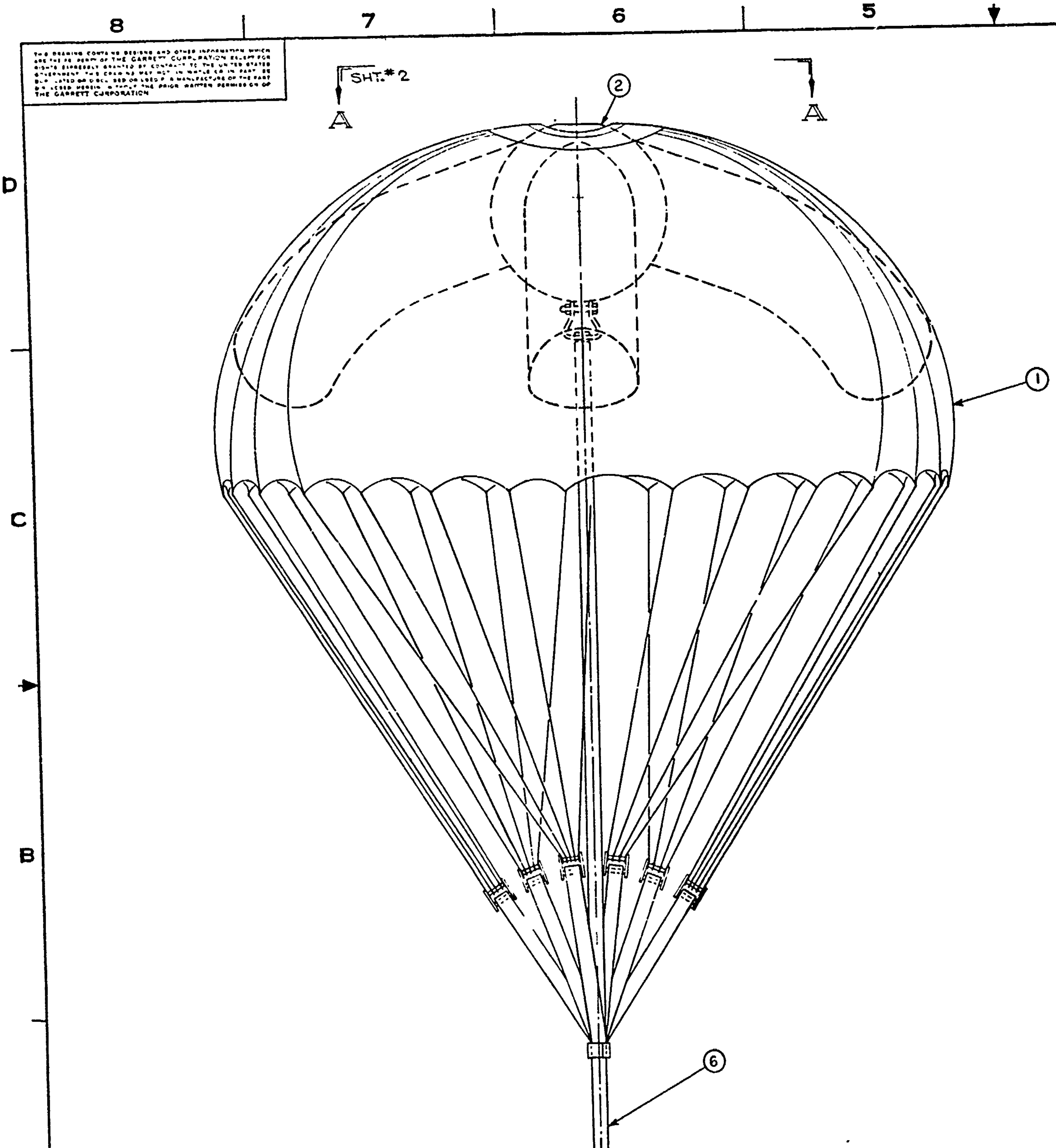
RECOVERY STRAP ASSEMBLY

SIZE	CODE IDENT NO.	DWG NO.
D	70167	ERD24739

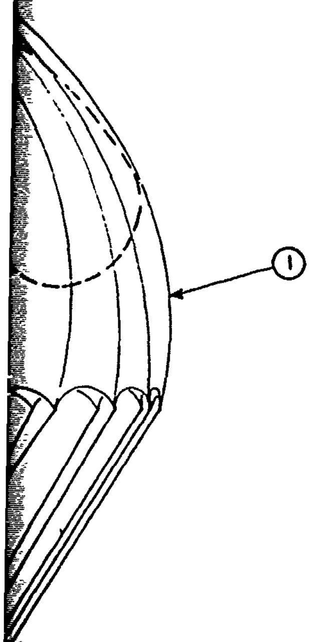
SCALE [illegible] | WT 10 LBS MAX. | SHEET 1 OF 1

DASH	NEXT ASSY	USED ON
101	D24752	T.B.D.

2


8
7
6
5
D
C
B
A
SHT.#2
A
A
2
1
6

REVISIONS				
E.C.N	SYM	DESCRIPTION	DATE	APPROVED
	A	EARLY RELEASE	[illegible]	[illegible]



NOTES:

1 MANUFACTURE PER AIR CRUISERS CO. STD. PRACTICES AS APPLICABLE.

QTY REQD	ITEM NO	PART NO.	SYM	DESCRIPTION	CODE IDENT	MATERIAL	SPECIFICATION	UNIT WT
1	6	D24752-101		PENDANT & RECOVERY STRAP ASSY				
1	5	[illegible]		LINK, S[illegible]T	16007			
1	4	[illegible]-101		[illegible] ATTACHMENT				
1	3	TBD		LIGHT, BEACON LOCATING				
1	2	[illegible]24745-10[illegible]		[illegible] ASSY				
1	1	[illegible]738-1		[illegible]				

101 ← ASSYS

LIST OF MATERIAL

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS .X ±
DECIMALS .XX ±
DECIMALS .XXX ±
FRACTION ±
ANGLES ±
SEE STANDARD PRACTICE #[illegible]

SIGNATURES	DATES
[illegible]	[illegible]

AIR CRUISERS COMPANY
BELMAR, NEW JERSEY

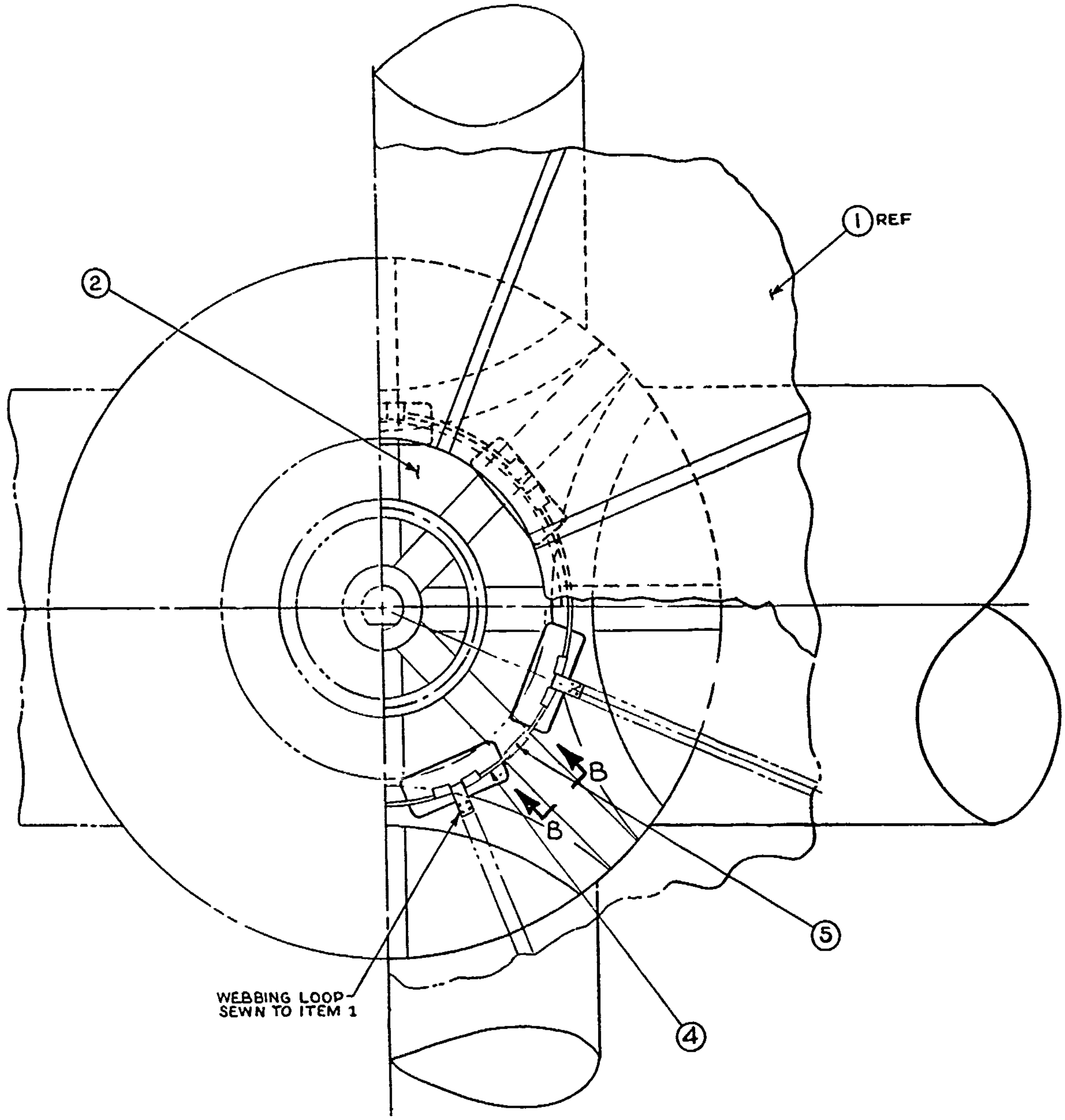
TITLE
RETARDATION/FLOTATION SUB-ASSEMBLY

SIZE	CODE IDENT NO	DWG NO.
D	70167	ERD 24740

SCALE [illegible] (CALCULATED) SHEET 1 OF 2

2

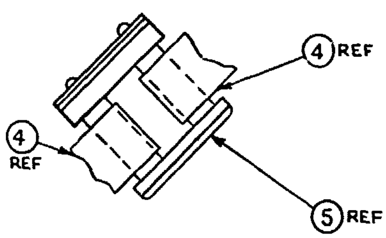
8 7 6 5



VIEW A - A

8 7 6 5

REVISIONS				
E.C.N	SYM	DESCRIPTION	DATE	APPROVED
	≠	SEE SHT 1 FOR LATEST REVISION		



VIEW B-B

QTY REQD	ITEM NO	PART NO.	SYM	DESCRIPTION	CODE IDENT	MATERIAL	SPECIFICATION	UNIT WT

←-- ASSYS

LIST OF MATERIAL

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS
DECIMALS
DECIMALS
FRACTION
ANGLES

SIGNATURES | DATES

AIR CRUISERS COMPANY
BELMAR, NEW JERSEY

RETARDATION/FLOTATION SUB-ASSEMBLY

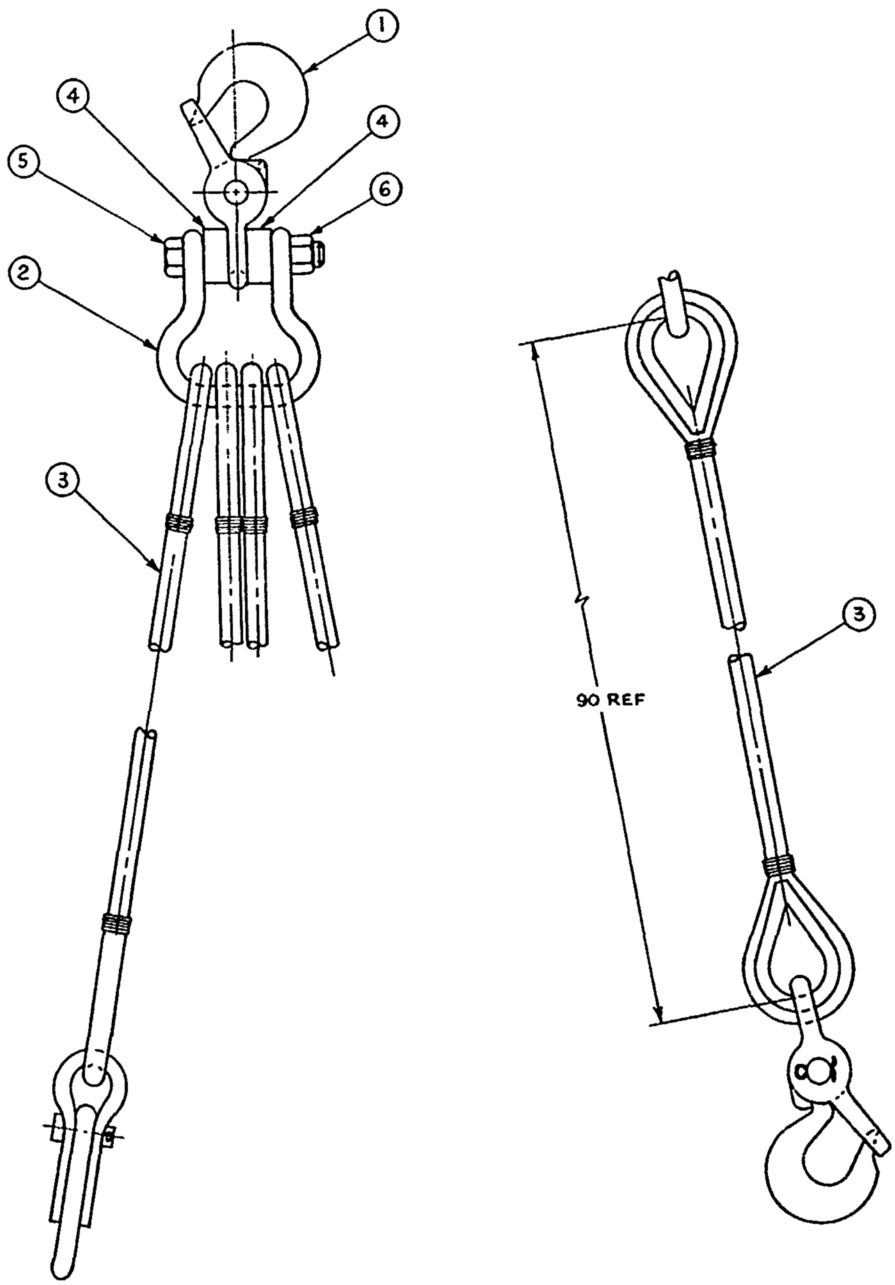
SIZE	CODE IDENT NO	DWG NO.
D	70167	ERD24740

SCALE NONE | WT | SHEET 2 OF 2

DASH	NEXT ASSY	USED ON

2

8 7 6 5



8 7 6 5

REVISIONS				
ECN	SYM	DESCRIPTION	DATE	APPROVED
	A	EARLY RELEASE	5/·/	7 ...

QTY REQD				ITEM NO.	PART NO.	SYM	DESCRIPTION	CODE IDENT	MATERIAL	SPECIFICATION	UNIT WT
			1	6	MS 35691-61		NUT, HEX				
			1	5	MS 90727-197		CAP SCR, HEX HD				
			2	4	TBD		SPACER				
			4	3	D24742-101		LEG ASSY, BRIDLE				
			1	2	MS 70087-2		CLEVIS, SUSPENSION				
			1	1	5166061		HOOK, SAFETY ADJ.	53711			

← ASSYS

LIST OF MATERIAL

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS .X ±
DECIMALS .XX ±
DECIMALS .XXX ±
FRACTION ±
ANGLES ±
SEE STANDARD PRACTICE #11

SIGNATURES	DATES
DFT	
CHK	
APP	

AIR CRUISERS COMPANY
BELMAR, NEW JERSEY

TITLE
RAFT CARGO
BRIDLE ASSEMBLY

SIZE	CODE IDENT NO.	DWG NO.
D	70167	ER D24741

SCALE NONE | WT 30 LBS (CALCULATED) | SHEET 1 OF 1

101	FINAL	FINAL
DASH	NEXT ASSY	USED ON

2

8 | 7 | 6 | 5

NOTES:

1. ONLY THE ITEMS DESCRIBED ON THIS DRAWING WHEN PROCURED FROM THE VENDOR(S) LISTED HEREIN IS APPROVED BY AIR CRUISERS CO. BELMAR, N.J. FOR USE IN THE APPLICATION(S) SPECIFIED HEREIN. A SUBSTITUTE ITEM SHALL NOT BE USED WITHOUT PRIOR APPROVAL BY AIR CRUISERS CO.

2. IDENTIFICATION OF THE APPROVED SOURCE(S) HEREIN IS NOT TO BE CONSTRUED AS A GUARANTEE OF PRESENT OR CONTINUED AVAILABILITY AS A SOURCE OF SUPPLY FOR THE ITEM DESCRIBED ON THIS DRAWING.

△3. APPROVED SOURCE OF SUPPLY: PRESCO INTERNATIONAL INC., 1110 THIRD STREET, NEW CUMBERLAND, PA., 17070.

△4. CORROSION RESISTANT STEEL PASSIVATED.

△5. HOSE MUST BE MULTIPLE PLY AND REINFORCED WITH NOT LESS THEN FOUR PILES. COVER AND TUBE TO BE NEOPRENE HOSE AND SHALL MEET TEST REQUIREMENTS OF SAE J20 TABLE 1 AND TESTED IN ACCORDANCE WITH PART XI, PHYSICAL TEST PROCEDURES, NUMBERS 1 THRU 10. CEMENT BOTH ENDS OF HOSE WITH RUBBER CEMENT TO PREVENT WICKING OF EXPOSED CARCASS OF FABRIC.

△6. ITEM 9 SHALL BE IN ACCORDANCE WITH ZZ-T-831, TYPE XI, CLASS 6, COLOR BLACK, AND 80-85 SHORE A DUROMETER PER FEDERAL TEST STANDARD 601. (TEST METHOD 3021)

(C1) 7. EYE SPLICES SHALL BE IN ACCORDANCE WITH BOATSWAIN'S MATE 3 AND 2, NAVY TRAINING COURSE MANUAL NAVPERS 10121 CHAPTER 3 (TYPICAL BOTH ENDS). SPLICES STRENGTH TO BE NOT LESS 90% OF MINIMUM BREAK STRENGTH OF ROPE. LENGTH OF BURIED SECTION OF EYE SPLICE SHALL BE 24.5^{+2}_{-0} INCHES (TYPICAL BOTH ENDS).

(M101) 8. ASSEMBLY MUST LAY FLAT WITH NO TWIST AFTER SPLICING.

△9. ITEMS 5 AND 12 SHALL BE IN ACCORDANCE WITH ASTM-D-1874-69 TYPE I AND ASTM-D-1785 TYPE I, GRADE 1, COLOR LIGHT GRAY, NO. 26280, PER FEDERAL STANDARD 595.

△10. THE FOLLOWING SHALL BE STEEL STAMPED IN .12 CHARACTERS AND FILLED WITH BLACK PAINT, TT-E-489. ALL CHARACTERS TO BE CENTERED AND VISUALLY BALANCED.

MFR'S INITIAL OR CODE	CONTRACT OR CODE NO.

△11. THE FOLLOWING MARKING SHALL BE STAMPED IN .25 CHARACTERS AND FILLED WITH BLACK PAINT, TT-E-489. 4000 POUND CAPACITY.

△12. STEEL STAMP IN .12 CHARACTERS D24752-101 AND REVISIONS LETTER TO WHICH PART IS MANUFACTURED AND FILL WITH BLACK PAINT, TT-E-489.

(C2) 13. PROOF TEST:
REACH TUBE ASSEMBLY: USING A 2 INCH DIAMETER (MIN) MANDREL AT EACH END. APPLY 12000 POUND LOAD, THEN RELEASE. ANY EVIDENCE OF FRAYING, CHAFING OR FAILURE OF PARTS AND SPLICES SHALL BE CAUSE FOR REJECTION.

(M102) △14. ITEM 3 SHALL BE PASSED THRU THE .250 DIA HOLES IN ITEMS 2 AND 1, THEN THREADED THRU ITEM 6 AS SHOWN IN SECTION B-B. THREAD ITEM 3 THRU ITEM 6 IN SUCH A MANNER AS NOT TO DESTROY THE ROPE FILAMENTS. TIE A TOTAL OF TWO (2) HALF HITCHES IN ITEM 3, ONE ON EACH SIDE. ADJACENT TO THE O.D. OF ITEM 2 180° APART. INTERWEAVE ITEM 3 AT LEAST FOUR (4) TIMES THRU THE WRAPPED PORTION OF ITEM 3. REPEAT THIS METHOD OF APPLYING ITEM 3 AT OPPOSITE ENDS OF PENDANT, ONLY THREADING COMPLETELY THRU ITEMS 11, 8 AND 6. AFTER COMPLETELY ASSEMBLING ITEM 3 ONTO ITEM 2 AND ITEM 11, RESPECTIVELY, COVER WITH LIQUID NYLON PER NAVSEASYSCOM DRAWING 2644647.

(M103) △15. UNIFORMLY DISTRIBUTE COAT WITHIN 20 PERCENT USING 4 OZ $^{+2}_{-0}$ OZ. PER FOOT OF ABRASION RESISTANT SOLUTION PER NAVSEASYSCOM DRAWING NO. 2644648-2

(M104) △16. POLYURETHANE TUBING MATERIAL AND TEST[...]
STANDARD 601:
A. 85-92 SHORE "A" DUROMETER (TEST ME[...]
B. 4500 PSI MINIMUM TENSILE STRENGTH (T[...]
C. 530% TO 650% MINIMUM ELONGATION ([...]
D. MAXIMUM TENSILE SET 20% - 25% (TE[...]
E. MAXIMUM COMPRESSION SET 22% AT 7[...]
F. COLOR - GLOSS BLACK.

△17. CEMENT IN PLACE WITH COMMERCIAL PV[...]

△18. THE POLYURETHANE MATERIAL USED IN T[...]
SHALL BE CAPABLE OF WITHSTANDING [...]
REQUIREMENTS: SHORE "A" HARDNESS [...]
THAN 8 POINTS FROM INITIAL VALUE AFT[...]
RELATIVE HUMIDITY

(M105) △19. FOR CERTIFICATION OF PROOF TEST, STENC[...]
FOLLOWING, USING MARKING INK, TT-I-[...]
DATE TESTED
MFP
SAFE WORKING LOAD 4000 LBS.

20. CLASSIFICATION OF CHARACTERISTICS (W[...]
CRITICAL - 3
MAJOR - 13
MINOR - ALL OTHERS

(M 06) △21. THE NYLON YARN USED SHALL BE A LON[...]
HEXAMETHYLENE DIAMINE AND ADIPIC A[...]
AND LIGHT STABILIZED.

(C3) △22. BRAIDED NYLON TWINE, TYPE 66, 550 [...]
NATURAL SHALL BE USED FOR SEIZING.
300 PSI MINIMUM. SEIZING SHALL CON[...]
HALF-HITCHES AROUND BITTER END PO[...]
WITH SUFFICIENT TURNS AND TENSIO[...]
PREVENT THE EYE SPLICE FROM PULL[...]
IN THE RELAXED CONDITION. SEIZING [...]
WHILE UNDER TEST LOAD.

8 | 7 | 6 | 5

E.C.N.	SYM	DESCRIPTION	DATE	APPROVED
	A	EARLY RELEASE		

REVISIONS

ETHANE TUBING MATERIAL AND TESTED IN ACCORDANCE WITH FEDERAL
ARD 601 :
92 SHORE "A" DUROMETER (TEST METHOD 3021) .
0 PSI MINIMUM TENSILE STRENGTH (TEST METHOD 4111) .
% TO 650% MINIMUM ELONGATION (TEST METHOD 4121) .
XIMUM TENSILE SET 20% - 25% (TEST METHOD 4411) .
XIMUM COMPRESSION SET 22% AT 72° F (TEST METHOD 3311) .
LOR - GLOSS BLACK .

NT IN PLACE WITH COMMERCIAL PVC SOLVENT.

OLYURETHANE MATERIAL USED IN THE MANUFACTURE OF THE TUBING
BE CAPABLE OF WITHSTANDING THE FOLLOWING HYDROLYTIC TEST.
REMENTS : SHORE "A" HARDNESS SHALL NOT DECREASE MORE
8 POINTS FROM INITIAL VALUE AFTER 7 DAYS AT 97°C AND 95%
IVE HUMIDITY

ERTIFICATION OF PROOF TEST, STENCIL IN .18 CHARACTERS THE
WING, USING MARKING INK, TT-I-1795, COLOR BLACK:
TESTED

WORKING LOAD 4000 LBS.

IFICATION OF CHARACTERISTICS (WR-43)
AL - 3
- 13
- ALL OTHERS
YLON YARN USED SHALL BE A LONG CHAIN POLYMER MADE OF
METHYLENE DIAMINE AND ADIPIC ACID WHICH HAS BEEN HEAT
LIGHT STABILIZED .

ED NYLON TWINE, TYPE 66, 550 FEET PER POUND. COLOR
AL SHALL BE USED FOR SEIZING. TENSILE STRENGTH SHALL BE
SI MINIMUM. SEIZING SHALL CONSIST OF A MINIMUM OF FOUR
HITCHES AROUND BITTER END PORTION OF EYE SPLICE AND
SUFFICIENT TURNS AND TENSION ON THE STANDING PART TO
NT THE EYE SPLICE FROM PULLING OUT WHEN ASSEMBLY IS
RELAXED CONDITION. SEIZING MUST REMAIN IN PLACE
UNDER TEST LOAD .

SOURCE CONTROL DRAWING

QTY REQD	ITEM NO	PART NO.	SYM	DESCRIPTION	CODE IDENT	MATERIAL	SPECIFICATION	UNIT WT
AR	14			SEIZING		12 (M 13)		
1	13	D24739-101		RECOVERY STRAP, ASS'Y				
1	12	D24752-12		SLEEVE, 2" PIPE SCHEDULE 20		(M 13)	9	
1	11	D24752-11		SLEEVE, 2 3/8 ID × 7/32 WALL		5	SAE J20, PT I, CL SC	
1	10			CLAMP, HOSE, TYPE H, 3 × 3/4 W × .030 THK		4	WW-C-440	
1	9	D24752-9		TUBE		6		
1	8	-8		TUBE		K 12		
1	7	-7		BUMPER, 1 7/8 ID × 7/32 WALL		5	SAE J20, PT I, CL SC	
1	6	-6		ROPE, 7/8 DIA		NYLON 2	MIL-R-24050	
1	5	D24752-5		REACH TUBE, 68" LG 1 1/2 PIPE SCHED 80			9	
2	4			CLAMP, HOSE, TYPE H, 2 1/2 × 5/8 W × .030 THK		4	WW-C-440	
2	3	D24752-3		KEEPER ROPE		NYLON	MIL-R-24050	
1	2	D24752-2		SLEEVE, 1 7/8 ID × 7/32 WALL NOM		5		
1	1	D24752-1		TUBE, 1 1/2 OD × 3/16 WALL		4, P, (M 13)		

← ASSYS

LIST OF MATERIAL

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS .X ± DECIMALS .XX ± DECIMALS .XXX ± FRACTION ± ANGLES ± SEE STANDARD PRACTICE #11

SIGNATURES | DATES

AIR CRUISERS COMPANY
BELMAR, NEW JERSEY

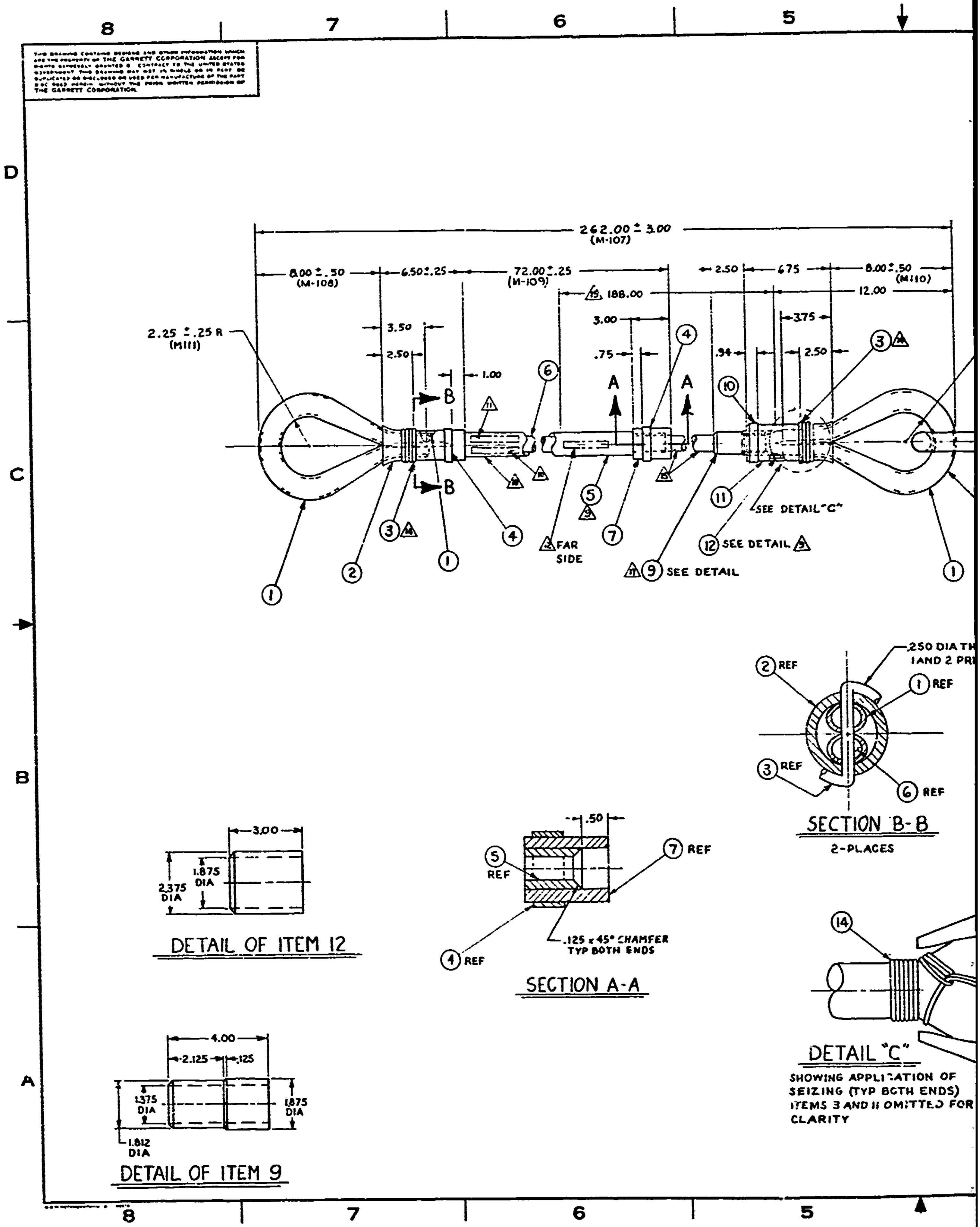
DWG TITLE
PENDANT AND RECOVERY STRAP ASS'Y.

SIZE	CODE IDENT NO.	DWG NO.
D	70167	ERD24752

SCALE NONE | WT T. B. D | SHEET 1 OF 2

DASH	NEXT ASSY	USED ON
-101	D24740	T B D

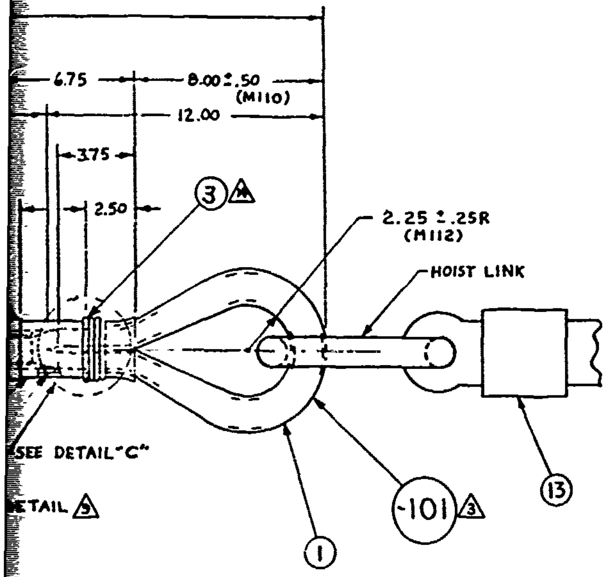
2

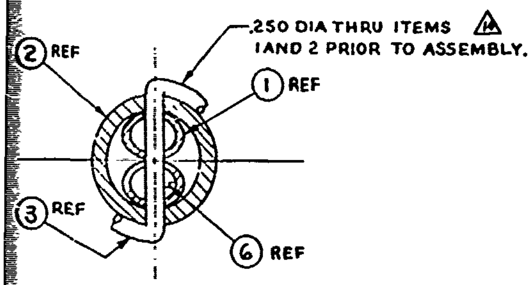


THE GARRETT CORPORATION
262.00 ± 3.00 (M-107)
8.00 ± .50 (M-108)
6.50 ± .25
72.00 ± .25 (M-109)
188.00
2.50
.675
8.00 ± .50 (M110)
12.00
2.25 ± .25 R (M111)
3.50
2.50
1.00
3.00
.75
.94
.375
2.50
SEE DETAIL "C"
FAR SIDE
SEE DETAIL
SEE DETAIL
.250 DIA TH
1 AND 2 PR
REF
SECTION B-B
2-PLACES
DETAIL OF ITEM 12
3.00
1.875 DIA
2.375 DIA
.50
.125 x 45° CHAMFER TYP BOTH ENDS
SECTION A-A
DETAIL "C"
SHOWING APPLICATION OF SEIZING (TYP BOTH ENDS) ITEMS 3 AND 11 OMITTED FOR CLARITY
DETAIL OF ITEM 9
4.00
2.125
.125
1.375 DIA
1.875 DIA
1.812 DIA

5 4 3 2 1

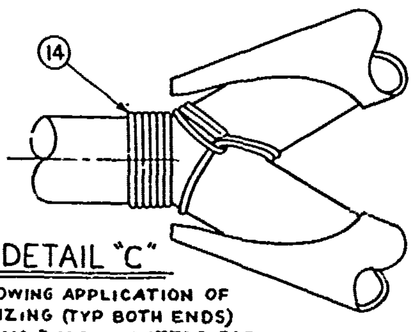
REVISIONS				
E.C.N.	SYM	DESCRIPTION	DATE	APPROVED
	*	SEE SHT 1 FOR LATEST REVISION		





SECTION B-B

2-PLACES



DETAIL "C"

SHOWING APPLICATION OF SEIZING (TYP BOTH ENDS) ITEMS 3 AND 11 OMITTED FOR CLARITY

QTY REQD	ITEM NO.	PART NO.	SYM	DESCRIPTION	CODE IDENT	MATERIAL	SPECIFICATION	UNIT WT
← ASSYS				LIST OF MATERIAL				

DASH	NEXT ASSY	USED ON

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS .X ± DECIMALS .XX ± DECIMALS .XXX ± FRACTION ± ANGLES ± SEE STANDARD PRACTICE #11

SIGNATURES	DATES
DFT	
CHK	
DFG GRP	
APP	
APP	
APP	
APP	
APP	
DESIGN ACTIVITY	
OTHER ACTIVITY	

AIR CRUISERS COMPANY
BELMAR, NEW JERSEY

DWG TITLE
PENDANT AND RECOVERY STRAP ASSY.

SIZE	CODE IDENT NO.	DWG NO.
D	70167	ERD 24752

SCALE NONE | WT | SHEET 2 OF 2

5 4 3 2 1

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